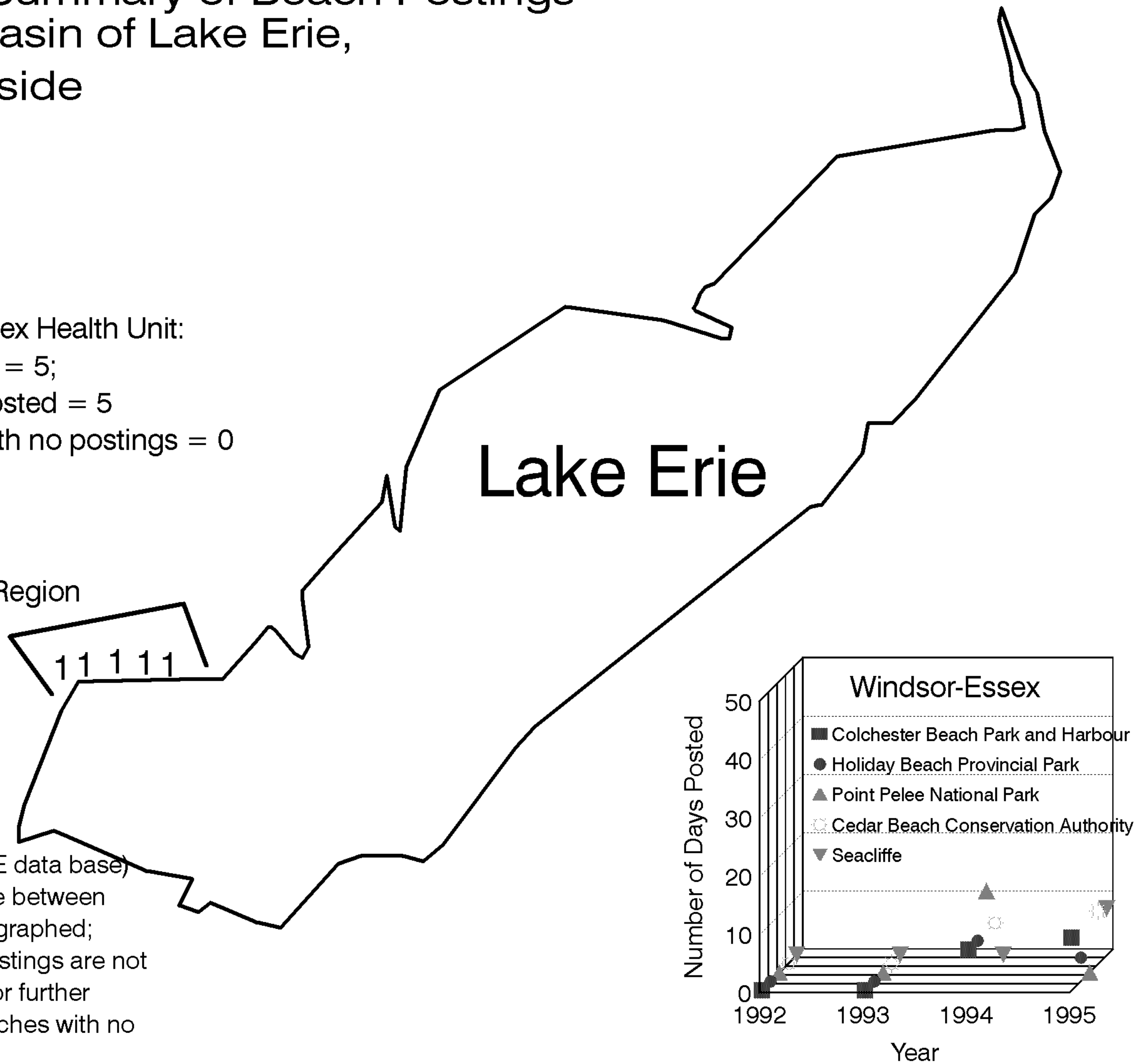
Figure 1: Summary of Beach Postings*
Western Basin of Lake Erie,
Canadian side

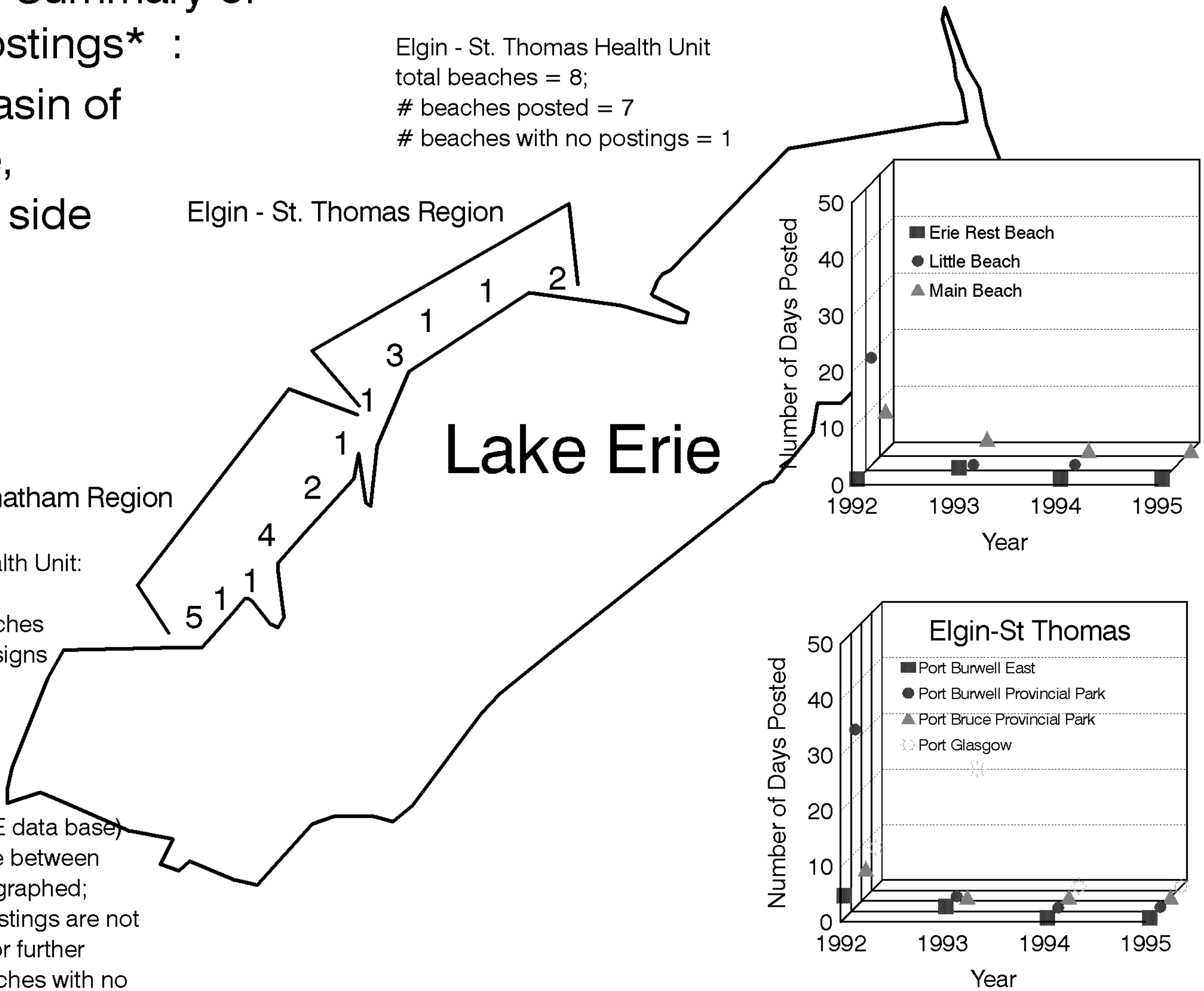
Windsor - Essex Health Unit:
total beaches = 5;
# beaches posted = 5
# beaches with no postings = 0

Windsor-Essex Region



* beaches (in OMEE data base) posted at least once between 1992 and 1995 are graphed; beaches with no postings are not graphed. See text for further information on beaches with no postings

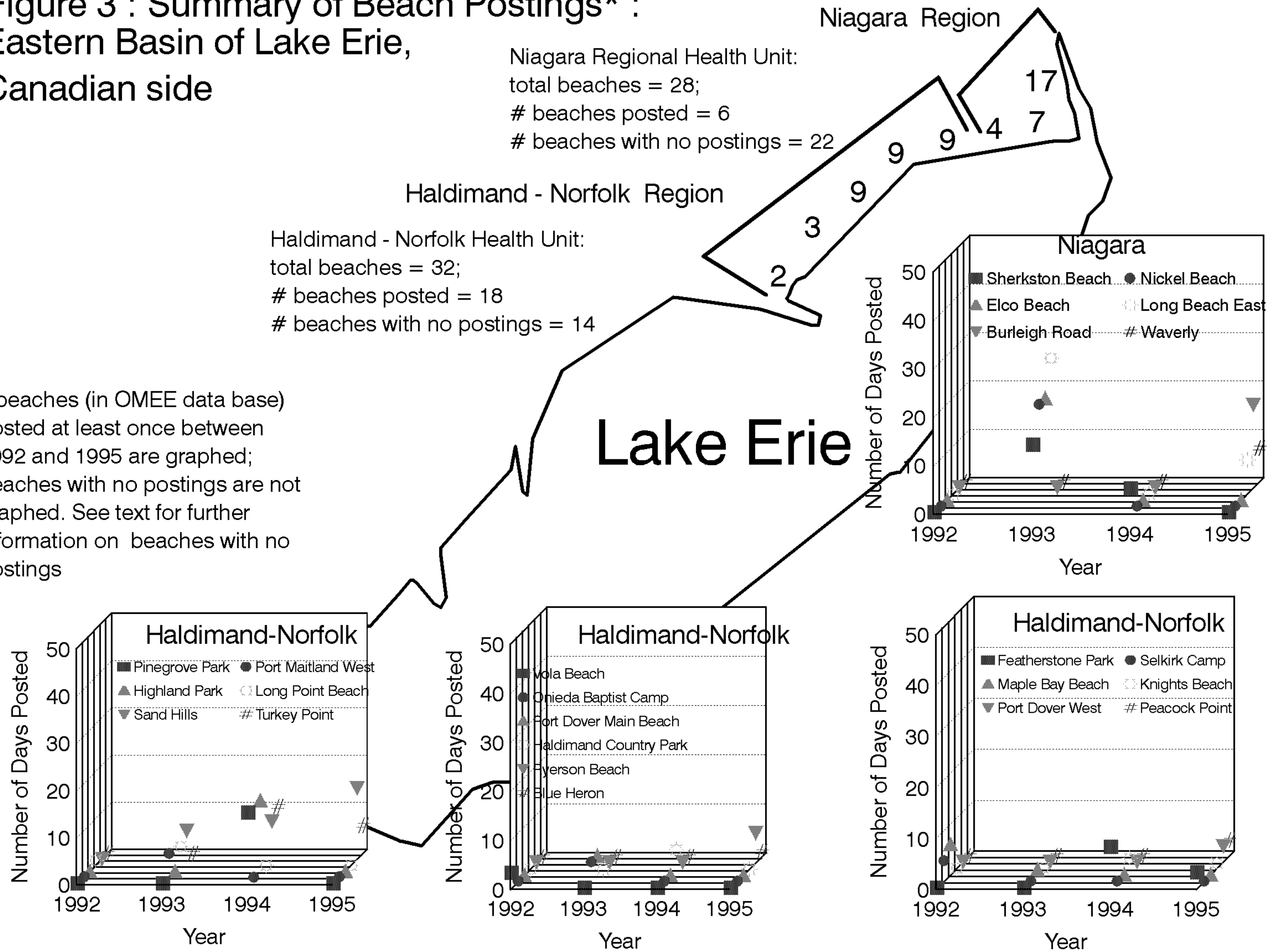
Figure 2: Summary of Beach Postings* : Central Basin of Lake Erie, Canadian side



Kent - Chatham Health Unit:
total beaches = 14;
no postings for beaches monitored; advice signs permanently posted instead

* beaches (in OMEE data base) posted at least once between 1992 and 1995 are graphed; beaches with no postings are not graphed. See text for further information on beaches with no postings

Figure 3 : Summary of Beach Postings* : Eastern Basin of Lake Erie, Canadian side



* beaches (in OMEE data base) posted at least once between 1992 and 1995 are graphed; beaches with no postings are not graphed. See text for further information on beaches with no postings

12.7 Limitations on the use of indicator organism data

Fecal coliforms and *E. coli* are both acceptable indicator organisms for assessing recreational water quality. However, they each have certain limitations:

- *E. coli* is better correlated with gastrointestinal illness than fecal coliforms (Robertson, 1993). Elevated fecal coliform counts do not always indicate a human health hazard. Fecal coliforms consist primarily of the organisms *E. coli* and *Klebsiella*. *Klebsiella*, present in pulp and paper mill effluents, can contaminate recreational waters, but is not considered to be a human health hazard in these waters (HWC, 1992). *Klebsiella* can sometimes be the predominant organism in a fecal coliform sample, causing an exceedance of the guideline and resulting in an unnecessary beach closure (Robertson, 1993). Some States (e.g. Ohio) and the Province of Ontario have switched to the use of *E. coli* as their indicator of choice.
- Neither *E. coli* nor fecal coliform testing differentiate between human or animal waste. This may pose a problem when the LaMP wants to identify sources.
- Neither fecal coliform counts nor *E. coli* counts measure levels of viruses, or non-fecal contaminants (e.g. *Staphylococcus*). Viruses and non-fecal contaminants are difficult to isolate and quantify at present (HWC, 1992), and feasible measurement techniques have yet to be developed.

12.8 Other Reasons for Beach Closures

There are other potential causes of recreational water quality impairment besides exceedances in bacterial levels. Bather illness or poisoning have been documented in Saskatoon (HWC, 1992) after immersion in lakes containing dense blooms of blue-green algae. Excessive growth of aquatic plants may cause entanglement and thereby constitute a hazard to recreational users. Extremes of alkaline and acidic waters could cause eye irritation. Recreational water should be clear enough so that swimmers can estimate depth and see subsurface hazards easily. In Ohio, other reasons cited included lack of lifeguards in one instance, and lightning in the area, requiring a temporary evacuation (Killinger unpublished report, 1995).

The beach monitoring reports filled in at the time of sampling are therefore helpful in identifying these other reasons for beach closures. As well, the annual or historical beach pollution surveys identify conditions with the potential to cause human health hazards.

12.9 Limitations on the Interpretation of Data

- Indicator organism data are limited, and therefore must be interpreted with caution. Measurements are generally taken only one to two times per week, and therefore only reflect the water quality for those days. If, for example, it rains every weekend, and samples are taken every Monday, there may be an exceedance of the guideline for every monitoring sample, even though the rest of the week is sunny and levels are likely to be within guidelines. Many beach monitoring protocols allow some flexibility for professional judgement as to when the beach is closed and re-opened (e.g. Ontario Ministry of Health, 1992).
- The monitoring criteria and the number of samples per month may have changed in some municipalities due to economic circumstances. Therefore, there is less data to work with, and therefore less statistical power to identify trends.
- Monitoring results take 24 hours or more to process. To protect health, beaches are often posted after heavy rainstorms, etc., until bacterial levels are confirmed. Conversely, beaches may not be posted until a series of consecutive samples demonstrates a continued exceedance of the guideline. A 1996 pilot study was conducted in Grand Bend, Ontario (Lake Huron basin), to test the efficacy of a new

sampling technique that provides results for fecal coliforms or *E. coli* in 6 hours or less (Palmateer *et al*, 1996). This rapid test yields accurate and timely results, allowing improved public health protection by prompt beach closures. This new technique, if adopted, will provide a more rapid evaluation of water quality so that Health Units can decide by early afternoon, before most people go swimming, if a beach should be closed.

- Bacterial levels data have been more difficult to obtain, especially electronic versions. Data must currently be obtained from each Health Unit, and has sometimes been in hard copy. Summary data were not available in some cases, and therefore there was a large amount of data that needed to be processed. This report includes the data summarized to date. Other data received will be included as it is processed.
- Historical data for *E. coli* counts in Ontario waters only goes back to 1992, because of the switch in monitoring from fecal coliform to *E. coli* from that year on. Therefore, Ontario data will only be considered from 1992 onward.
- "Indicator organism" counts can only be used at the individual beach level. Averaging bacterial counts to get a region-wide value would not give useful information on impairment.
- There may be subtle variations or regional differences in the collection methodology, or poor or variable reporting practices. Where and how each sample is taken is important in terms of a consistent or variable result.
- Indicator organisms only imply the relative chance that disease causing organisms may be present.

12.10 Data Gaps

To better assess this use impairment: a) a more comprehensive assessment of bacterial levels monitoring data could be considered for open recreational waters and embayments that are not necessarily public beaches, but are nevertheless used for total or partial body contact recreation, and b) bacterial levels data is needed for all private and unofficial beaches.

Beaches may not be sampled as often as protocol recommends, for economic reasons or otherwise. We may want to work with the Health Units to supplement the bacterial levels data, for the purpose of monitoring trends. We may want to work with the Health units who do not have a Beach Pollution Survey or related information to put one together. Dates and lengths of beach postings would be useful to have as well.

The information on microbial contaminant sources for beaches was provided by personal communication with each Health Unit based on historical information. Primary sources of microbial contamination need to be verified and documented for individual beaches to assist in the determination of which direction research, monitoring and remediation activities should take.

12.11 Future Analyses

Rain, wind, water temperature and bather load data would be useful for making correlations with bacterial levels. Historical data tend to correlate rainfall and wind with bacterial exceedances. Rain can cause combined sewers to overflow, causing an elevation of bacterial levels up to 48 hours after the rain event. High winds can increase wave action, which can suspend sands and result in elevated bacterial levels. Water temperature may play a role in bacterial growth. Possible future work by Health Canada includes collecting and graphing environmental data against bacterial levels exceedances.

Data on other contaminants in recreational water, such as viruses, parasites, and toxic chemicals, also need to be collected, but may be more difficult to obtain. Chemical contaminants such as polycyclic aromatic hydrocarbons (PAHs) are of concern for dermal (skin) exposure in recreational waters.

Unfortunately, a wealth of information is not available regarding adsorption (contaminants sticking to the skin, and the potential for skin rashes, etc.) or how much might be absorbed through the skin (and the potential to cause systemic effects). And finally, there is a need for unified sampling, reporting, and analytical methods.

A lifetime risk assessment from dermal exposure to PAHs in St. Marys River (ON) indicates that the lifetime health risk of skin cancer was well below the negligible risk range at inshore locations (Hussain et. al., 1995). However, some upstream sites had risk values higher than the negligible risk range and this may be cause for some concern. The report states that the risk can be significantly reduced, even to the point of becoming negligible, if recreational water use by the individual is modified (e.g. reducing the number of times the water is used, and/or showering soon thereafter). There are also human contact advisories issued by the Ohio Department of Health, for segments of the Black and Ottawa Rivers in Ohio. PAHs and PCBs, respectively, are responsible for these advisories. Due to elevated concentrations of these contaminants and their impact on the fish in these rivers, precautionary advisories against human contact were issued.

At present, the U.S. Geological Survey is investigating the importance of sediment-stored fecal coliforms and *E. coli* and the role of physical disturbances (i.e., wind, wave action, the swimmers themselves) on the recreational water-quality of nearshore zones of public bathing beaches of Lake Erie (Francy, 1996).

12.12 Making the link to health outcomes

Finally, more research is needed to correlate prevalence of waterborne illness with levels of bacterial contamination, a challenging task. Some preliminary reports have been written on this issue, and further research is ongoing to understand the relationship. For example, the US EPA has estimated that the use of an illness rate of 8 individuals per 1,000 swimmers for a geometric mean of 126 *E. coli* /100 ml water may be helpful in predicting the potential for waterborne illness as a result of bacterial contamination (D. Killinger, personal communication).

12.13 Impairment Conclusions

Bacterial levels exceedances are occurring throughout the Lake Erie basin. Therefore, it is recommended that Lake Erie basin nearshore recreational water quality be classified as impaired from a human health (i.e. bathing use) standpoint. The critical pollutant, defined as the cause of the beneficial use impairment discussed in this report, is microbiological contamination based on the *E. coli* and fecal coliform data reviewed.

Bacterial levels data examined in this assessment provide support for a conclusion that recreational use of Lake Erie offshore is unlikely to be impaired by bacteria. However, the Lake Erie LaMP has decided to classify the use impairment for recreationally used “open waters” as “inconclusive”, since a comprehensive assessment of the open waters data was not undertaken.

These conclusions are based on all sources of impairment, and are not dependent upon whether or not the sources can be remediated. Some remediation, such as separating combined sewers or building storm/sanitary sewer overflow tanks is expensive and therefore remediation is a long-term project. Other sources, such as seagulls and bather load may not be able to be remediated. It is recommended that a long-term plan be developed to identify the sources that can be remediated, the costs, and the time lines. Identification of sources is an important beginning to the remediation process. It should be noted that, although it may not be feasible to eliminate bacterial levels exceedances completely, much work has been done over the past number of years to remediate microbiological sources of contamination, and this is likely a great contributor to the reduction of exceedances. As sources continue to be remediated, it is hypothesised that bacterial levels exceedances will continue to decline.

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Appendix A
Bacterial Levels Graphs

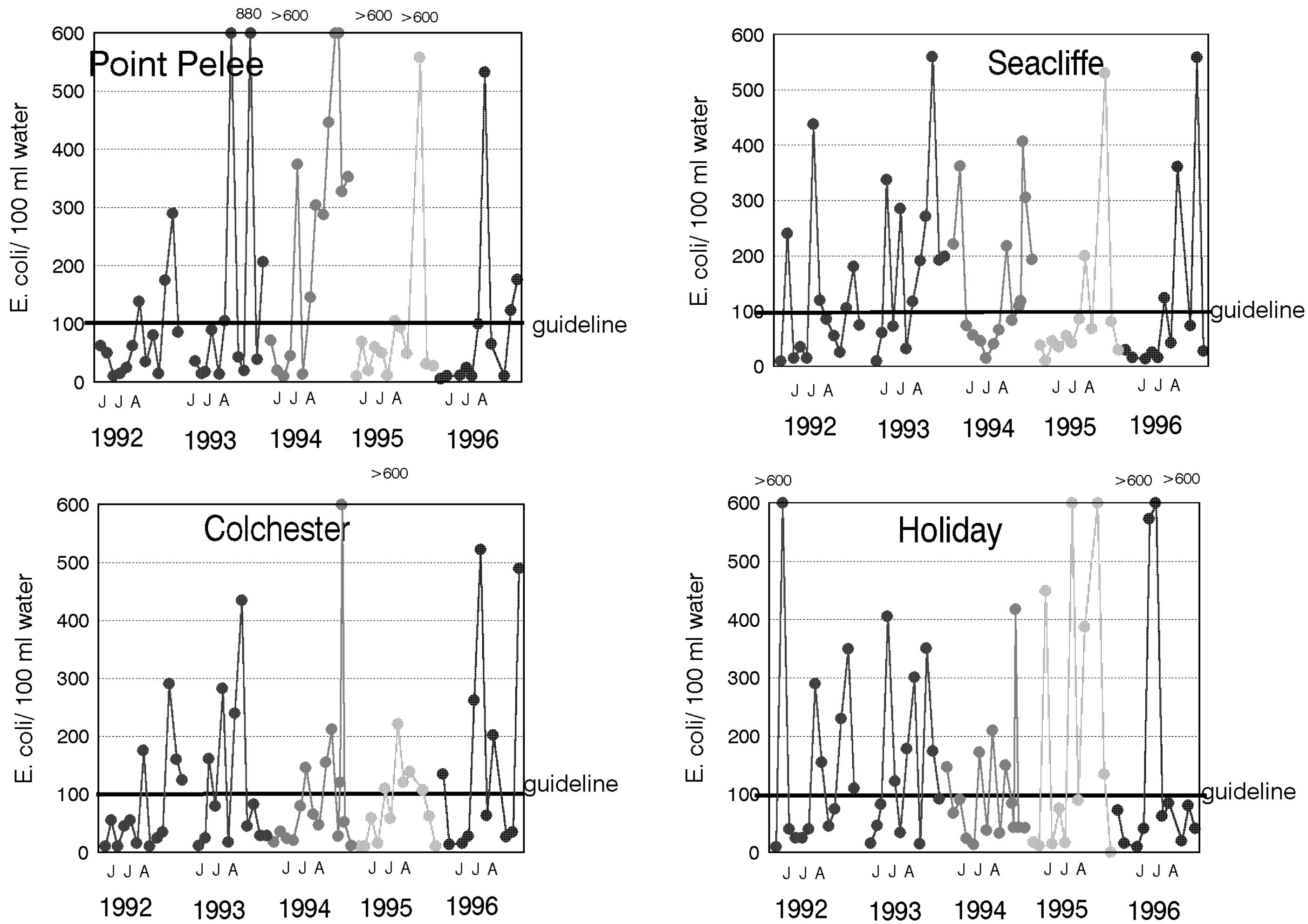

Figure 12-1: Geometric Mean of E. coli Levels in Windsor-Essex beaches, Lake Erie

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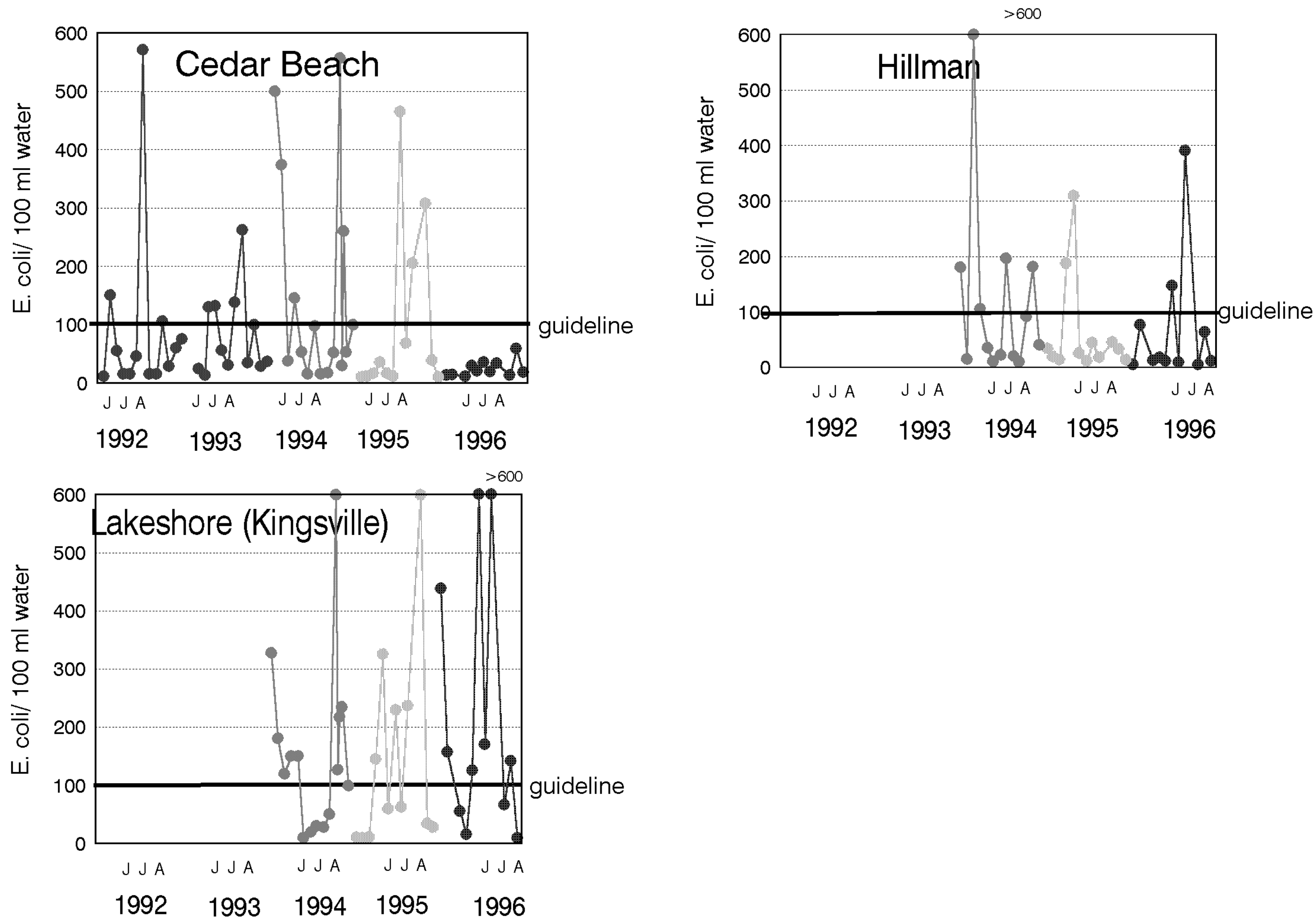

Figure 12-2: Geometric Mean of E. coli Levels in Windsor-Essex beaches, Lake Erie

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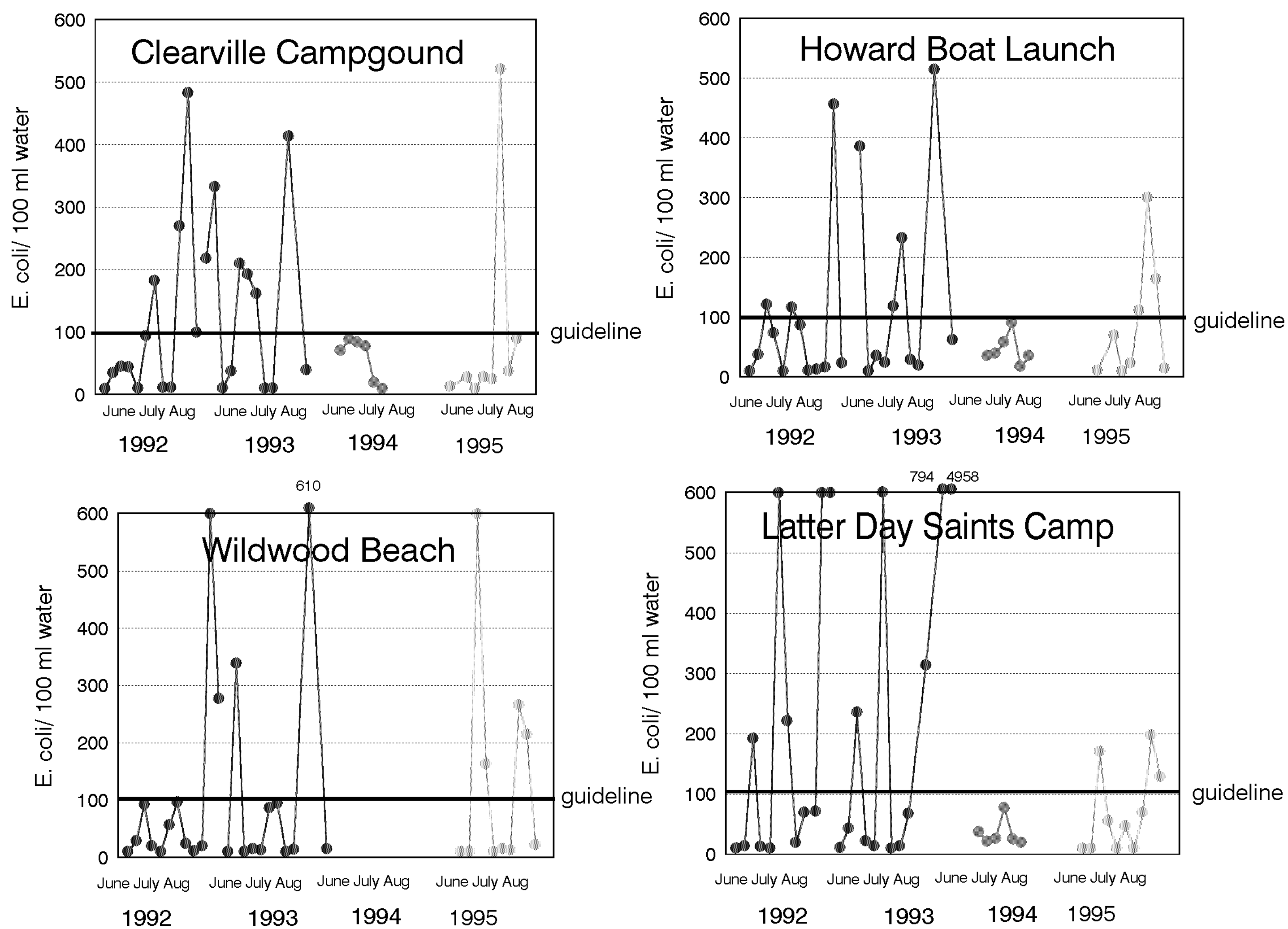

Figure 12-3: Geometric Mean of E. coli Levels in Kent-Chatham beaches, Lake Erie

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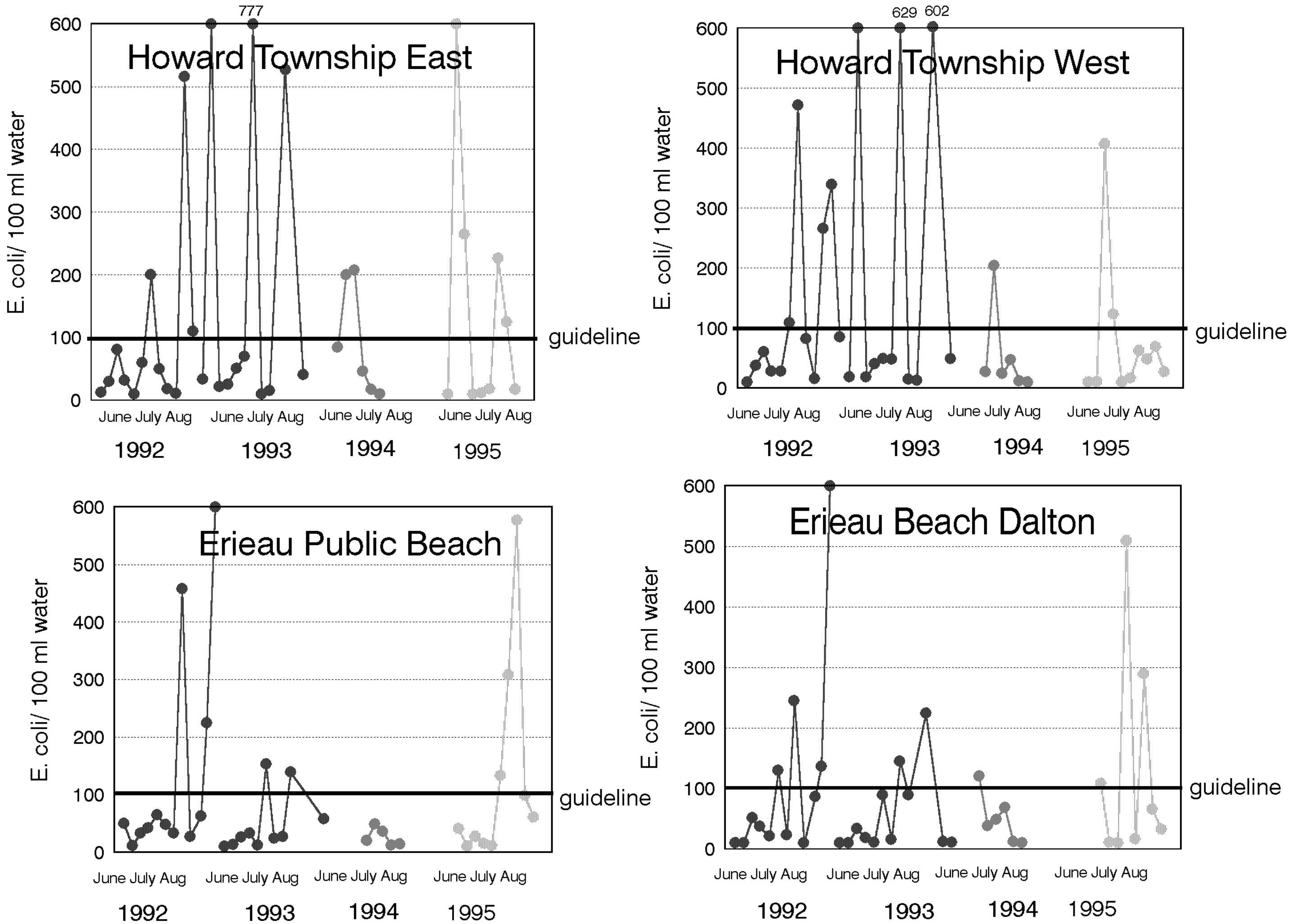

Figure 12-4: Geometric Mean of E. coli Levels in Kent-Chatham beaches, Lake Erie

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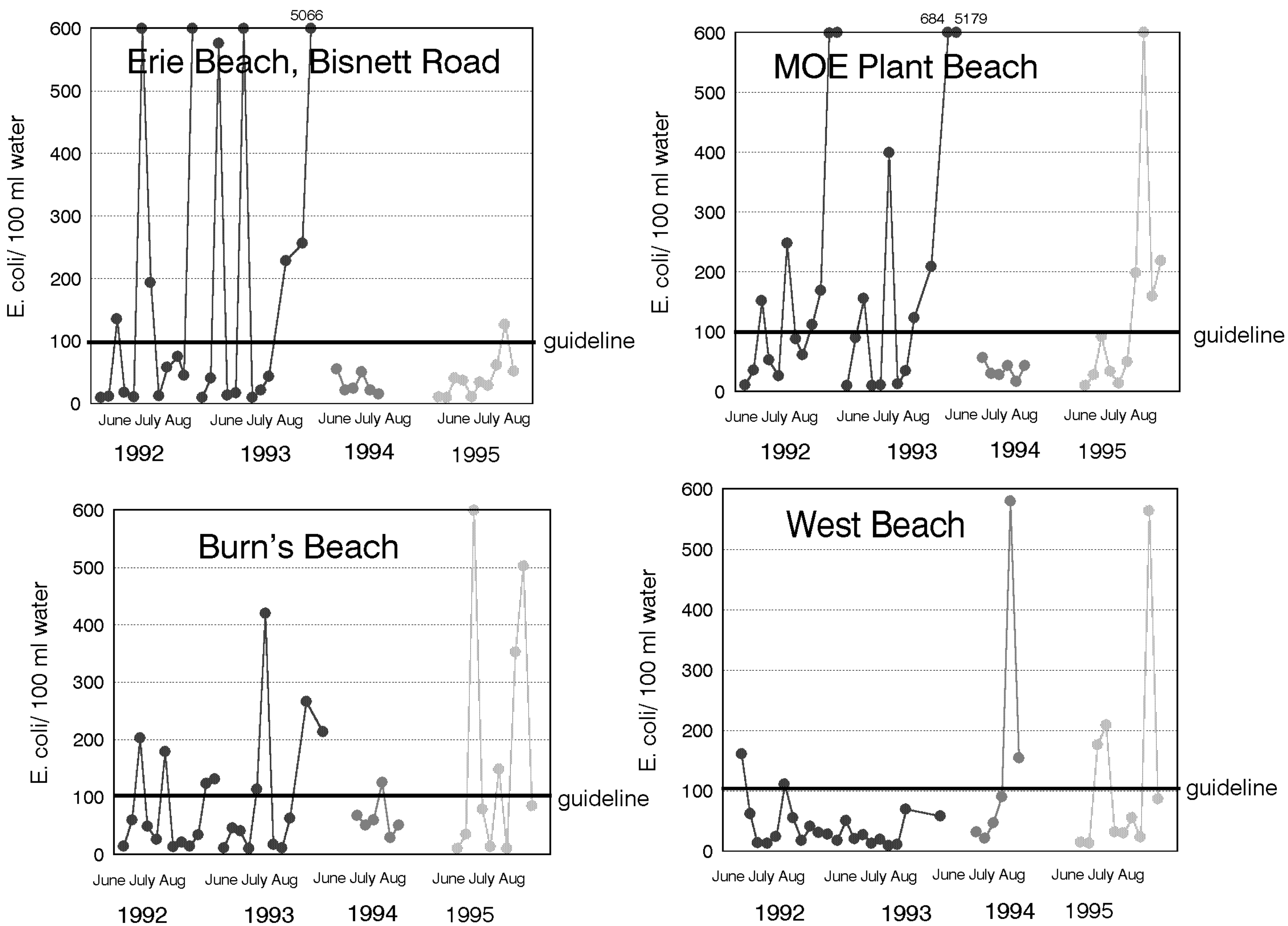

Figure 12-5: Geometric Mean of E. coli Levels in Kent-Chatham beaches, Lake Erie

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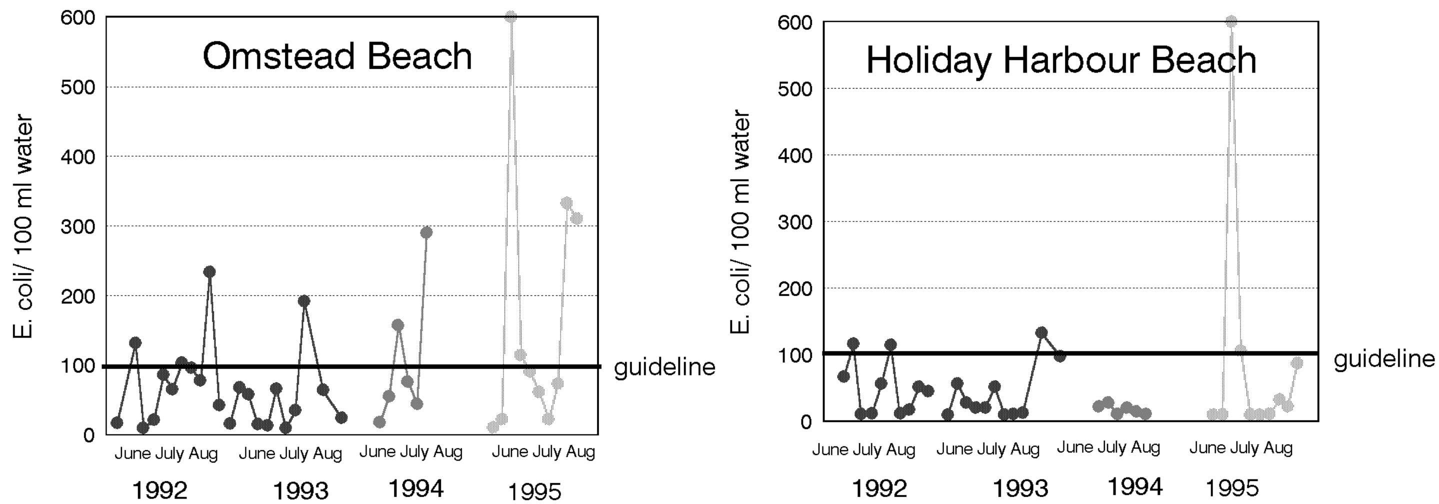

Figure 12-6: Geometric Mean of E. coli Levels in Kent-Chatham beaches, Lake Erie

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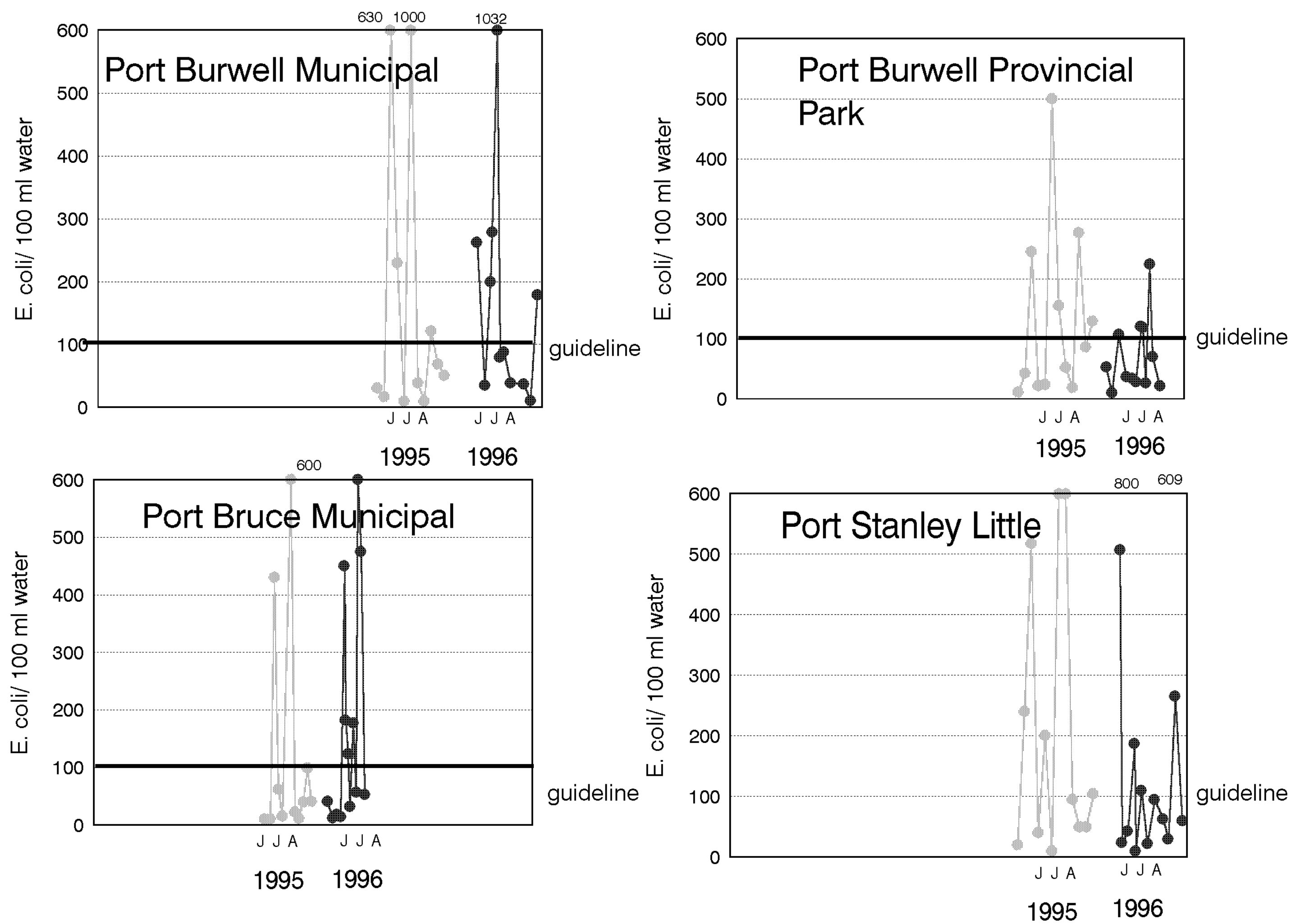

Figure 12-7: Geometric Mean of E. coli Levels in Elgin-St Thomas beaches, Lake Erie

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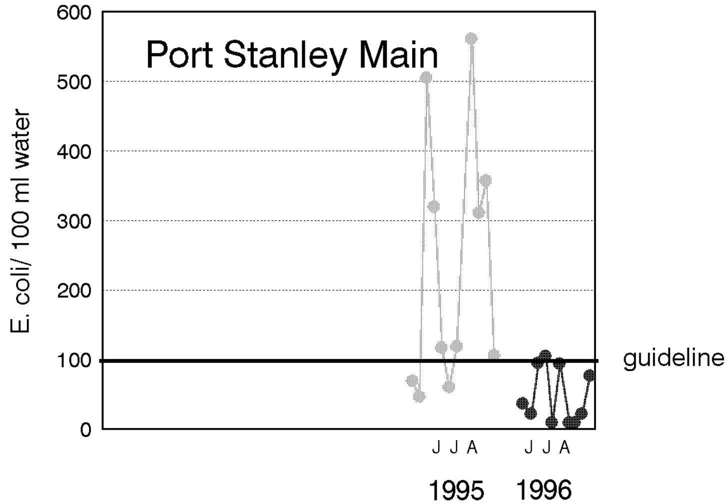

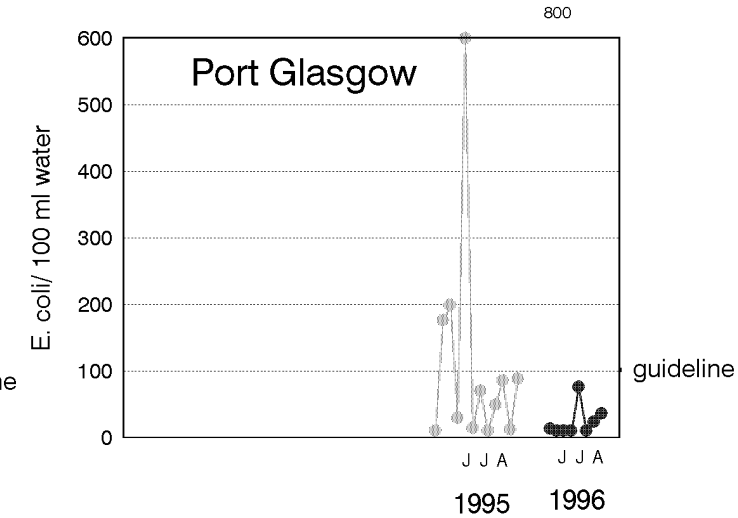

Figure 12-8: Geometric Mean of E. coli Levels in Elgin-St Thomas beaches, Lake Erie

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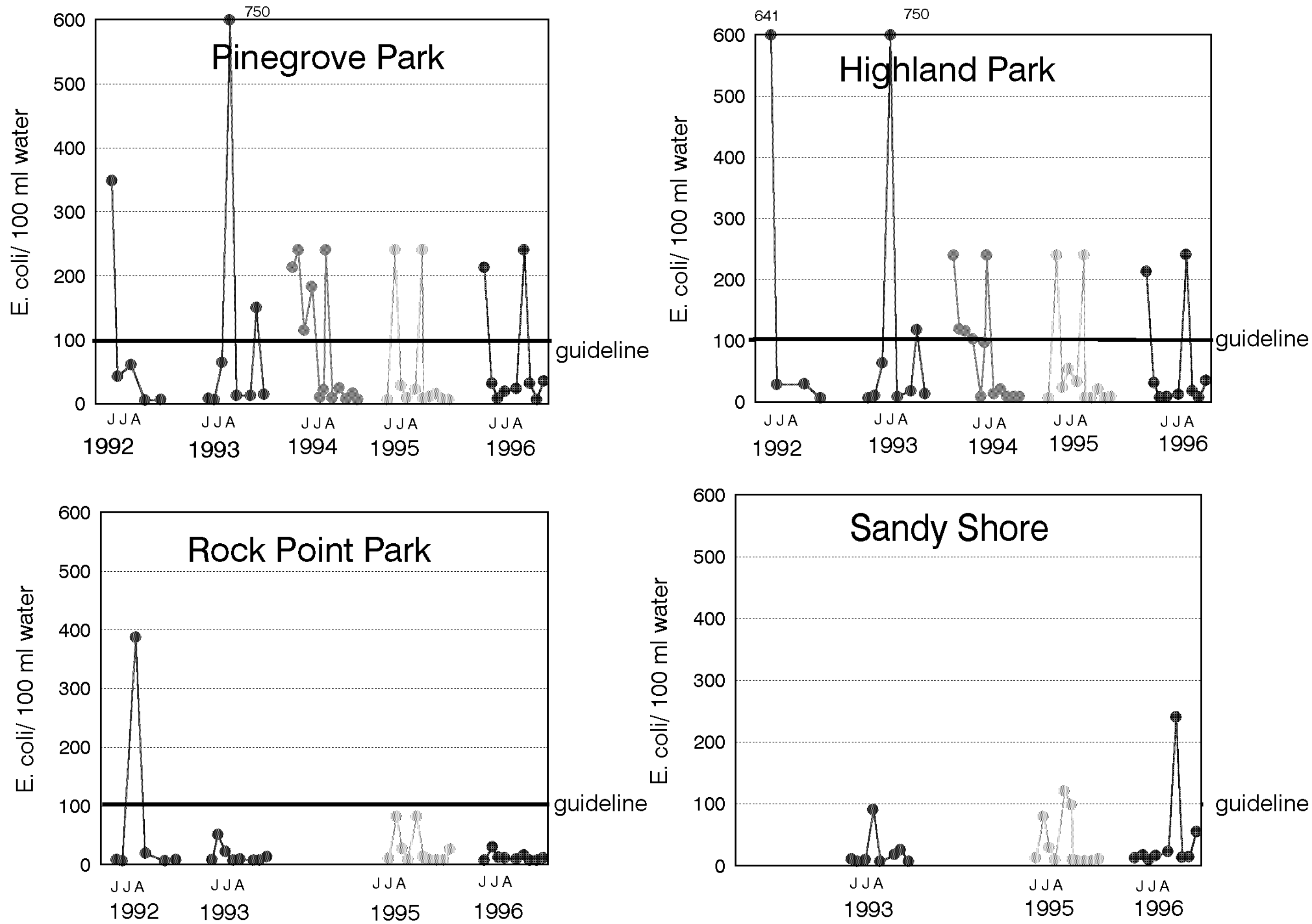

Figure 12-9: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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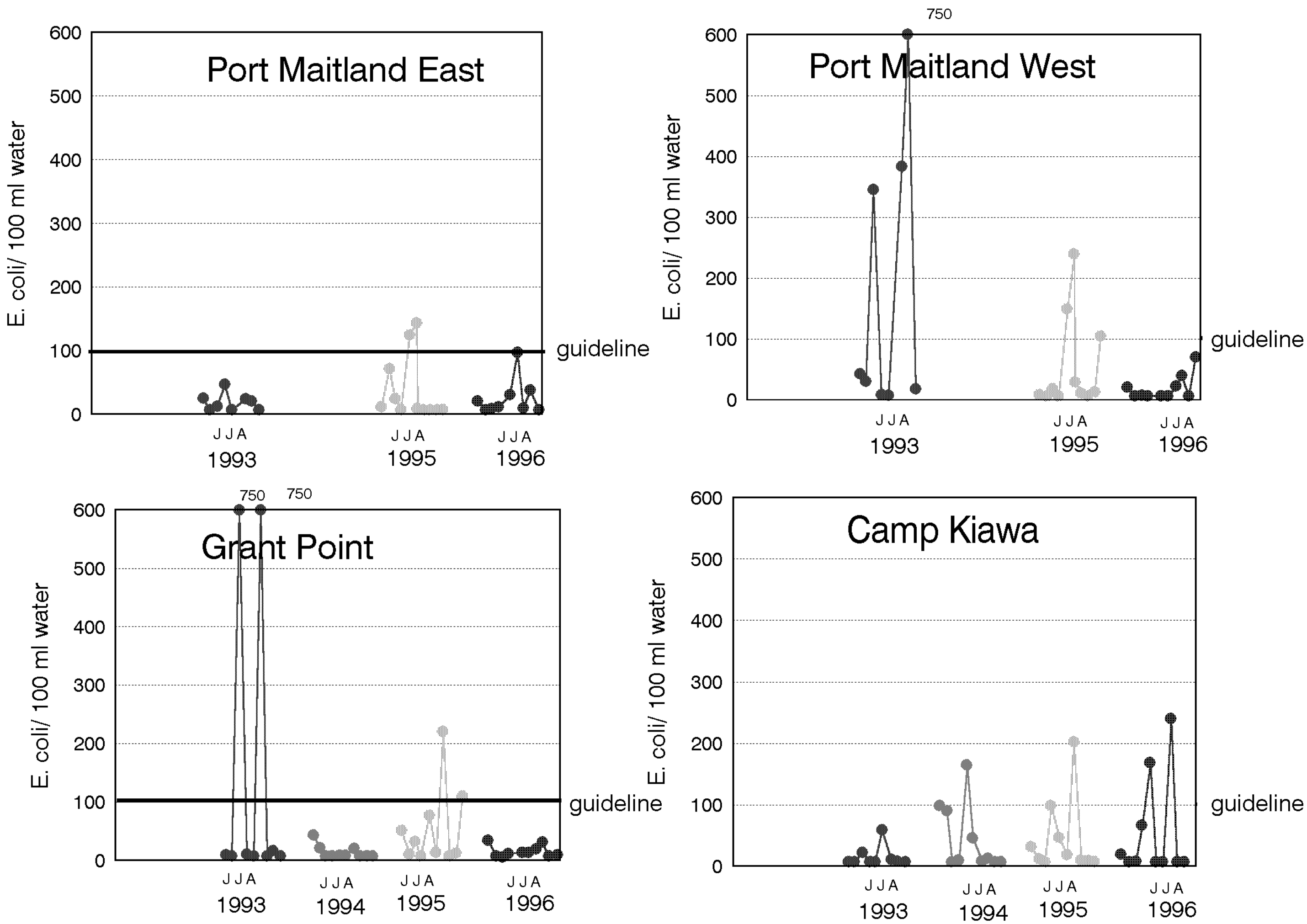

Figure12-10: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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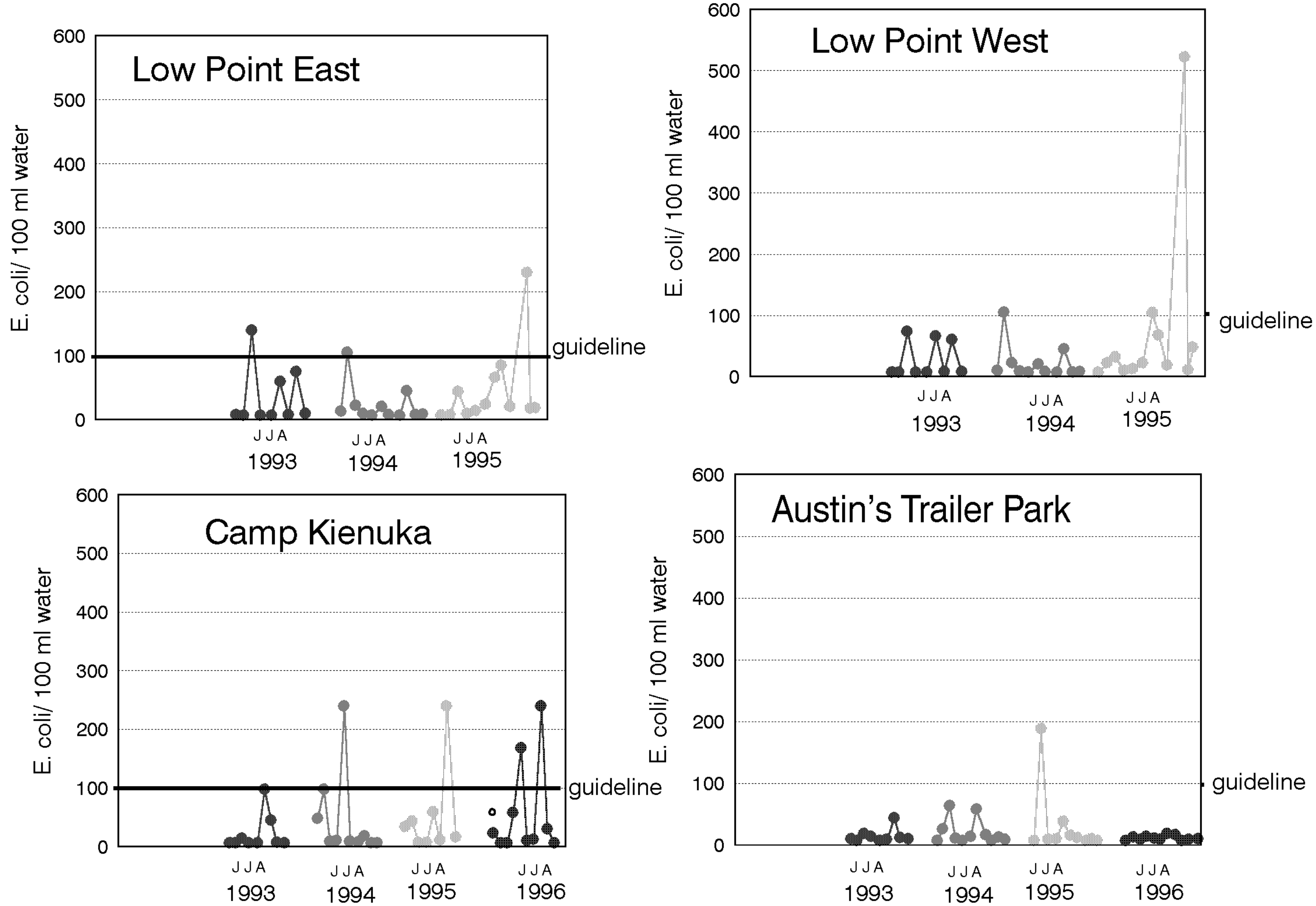

Figure 12-11: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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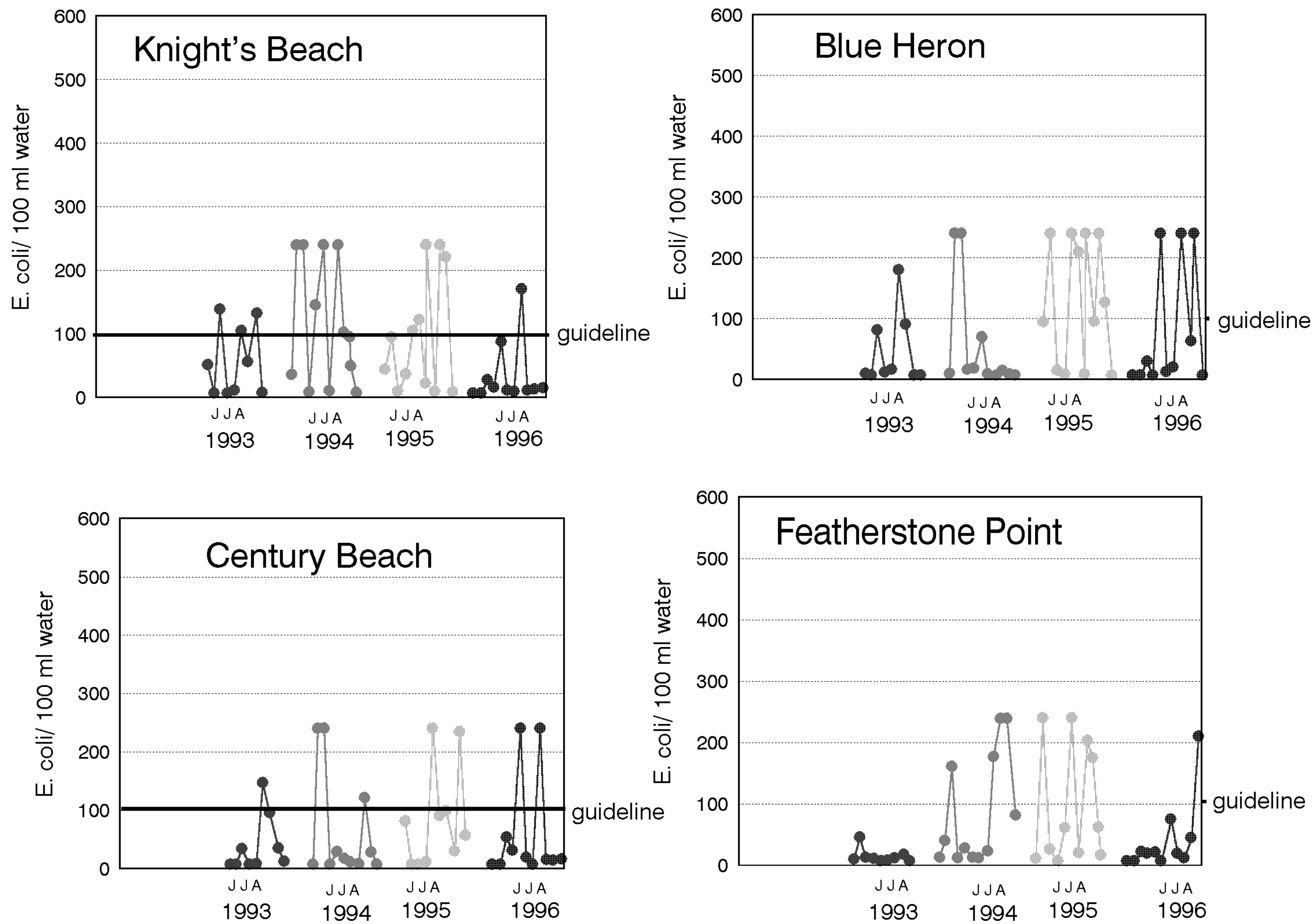

Figure 12-12: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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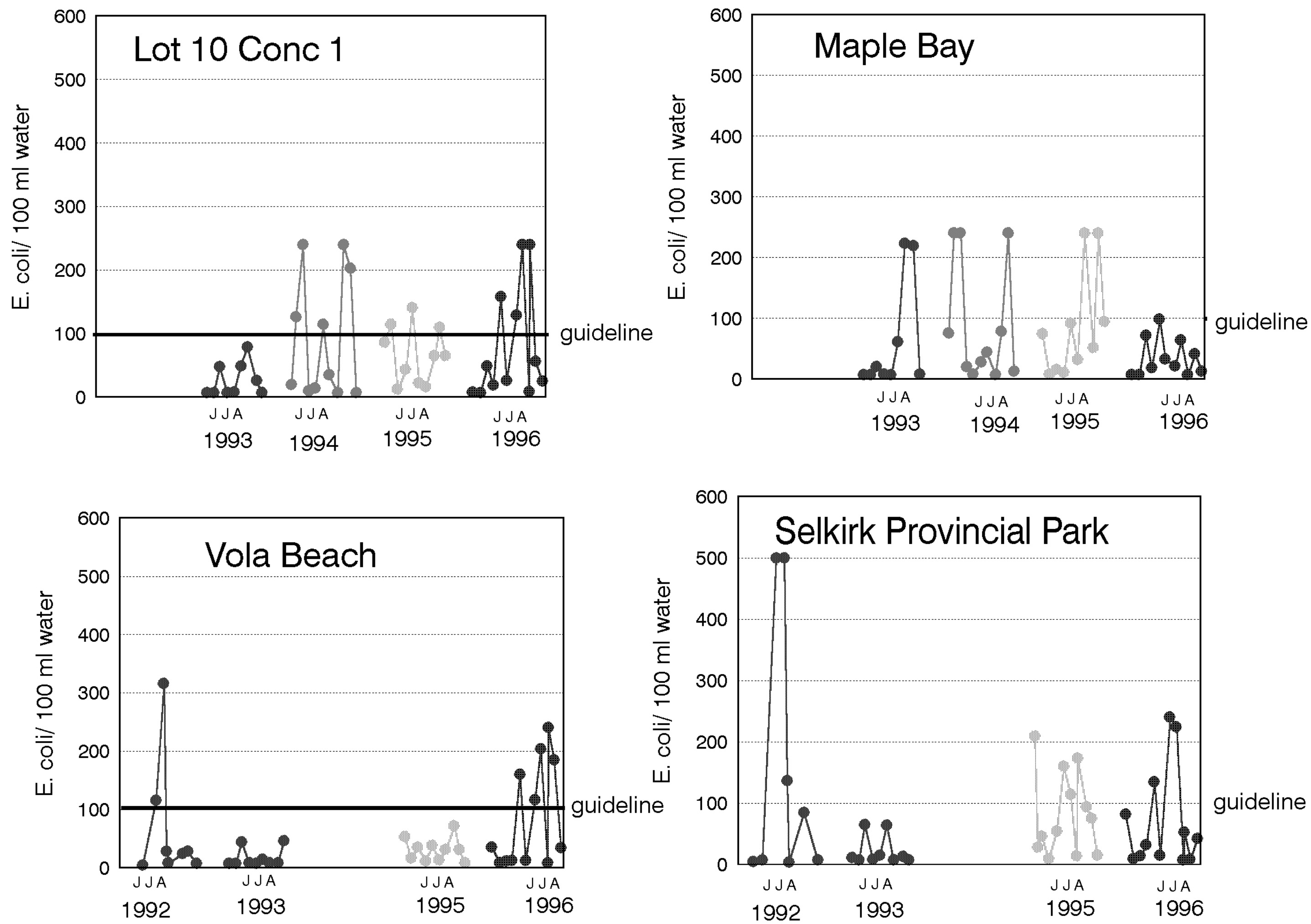

Figure 12-13: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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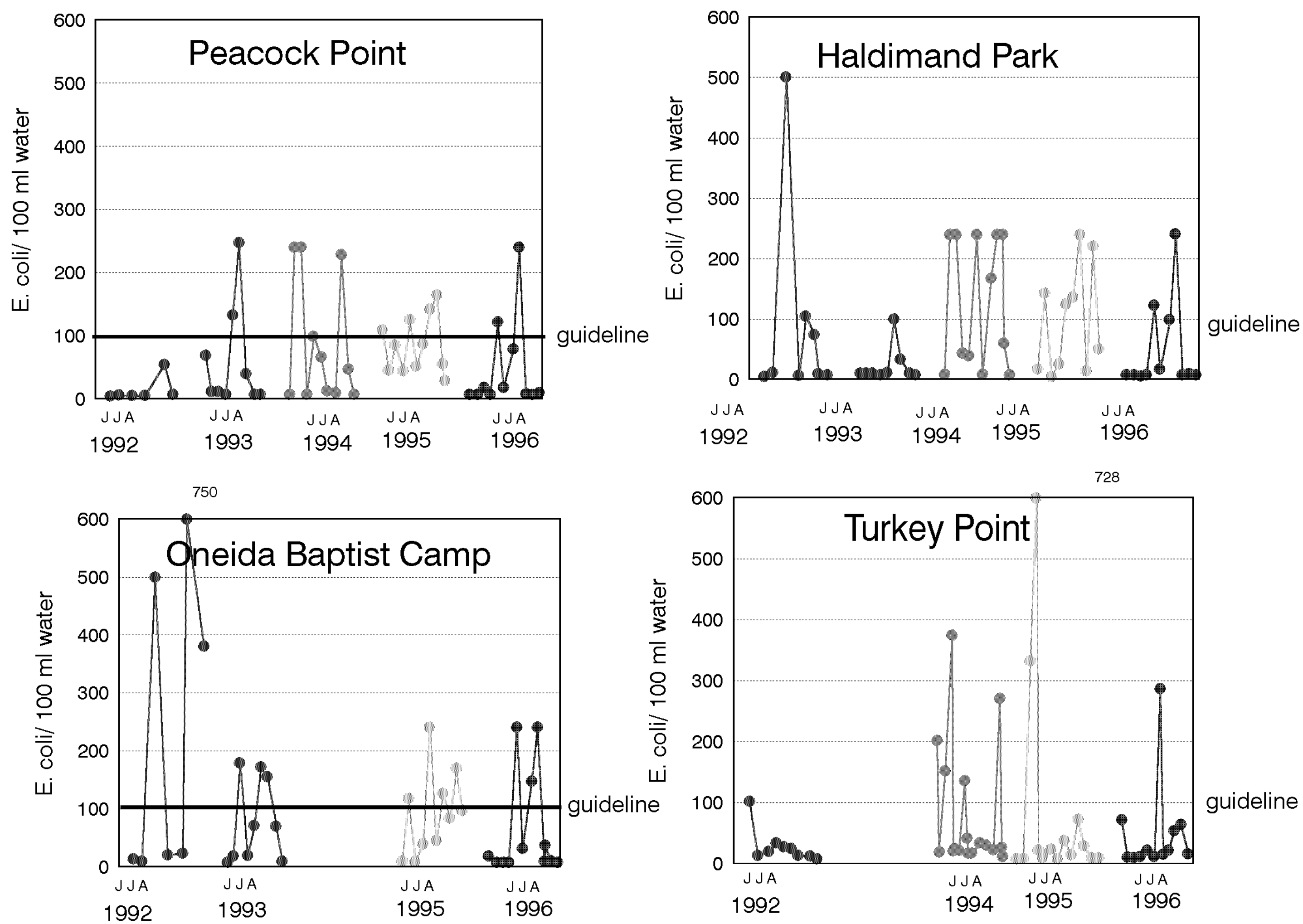

Figure 12-14: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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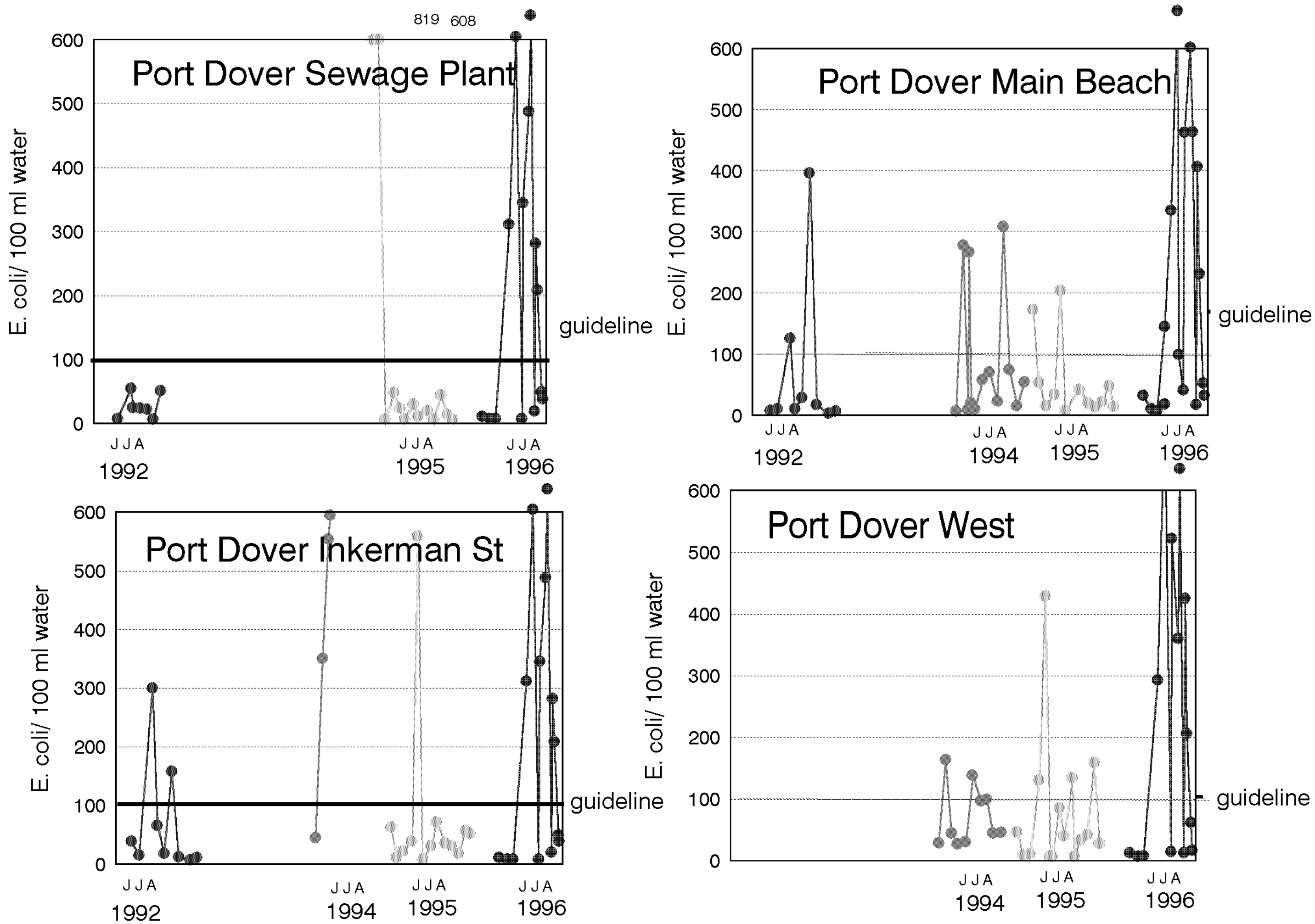

Figure 12-15: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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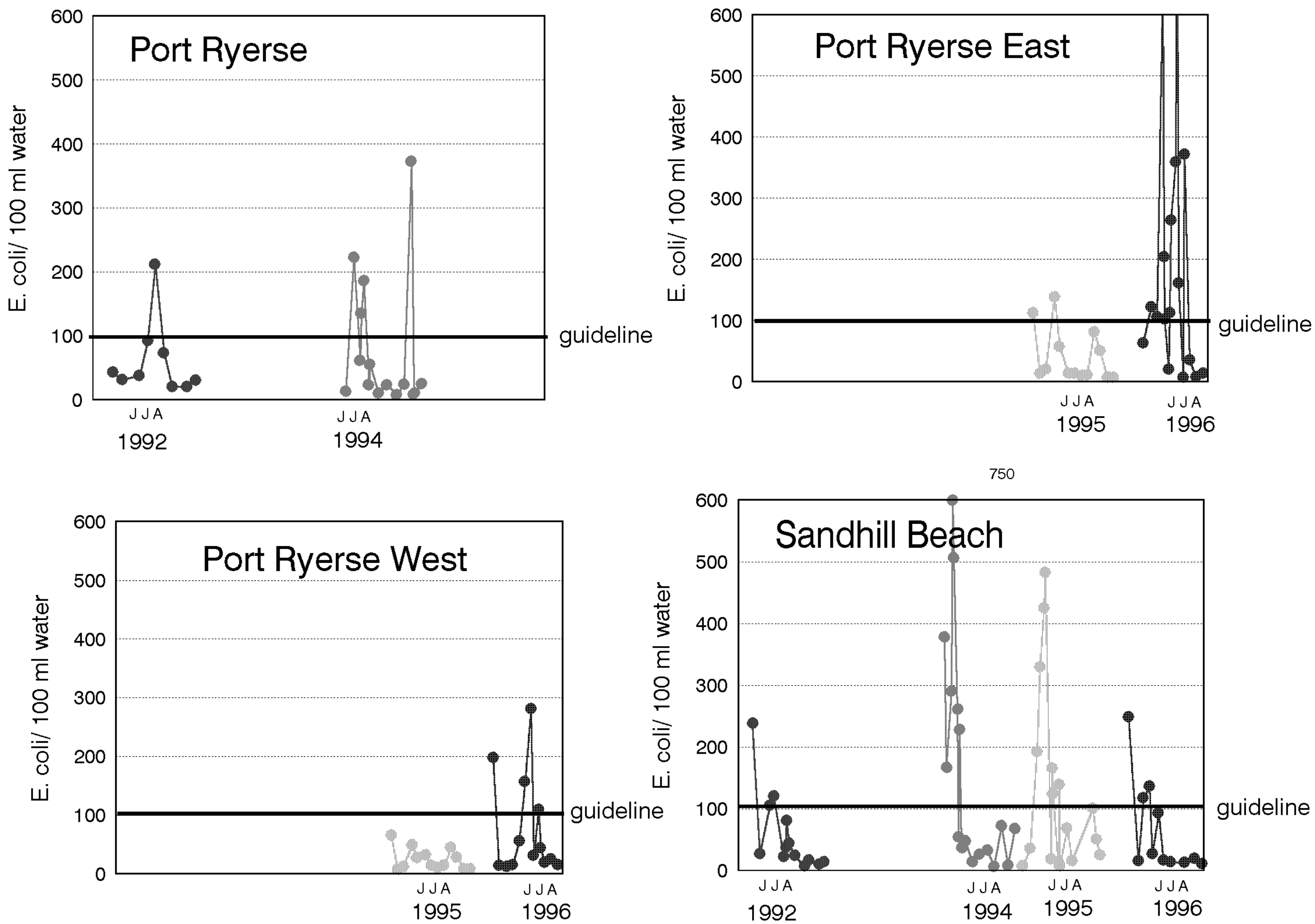

Figure 12-16: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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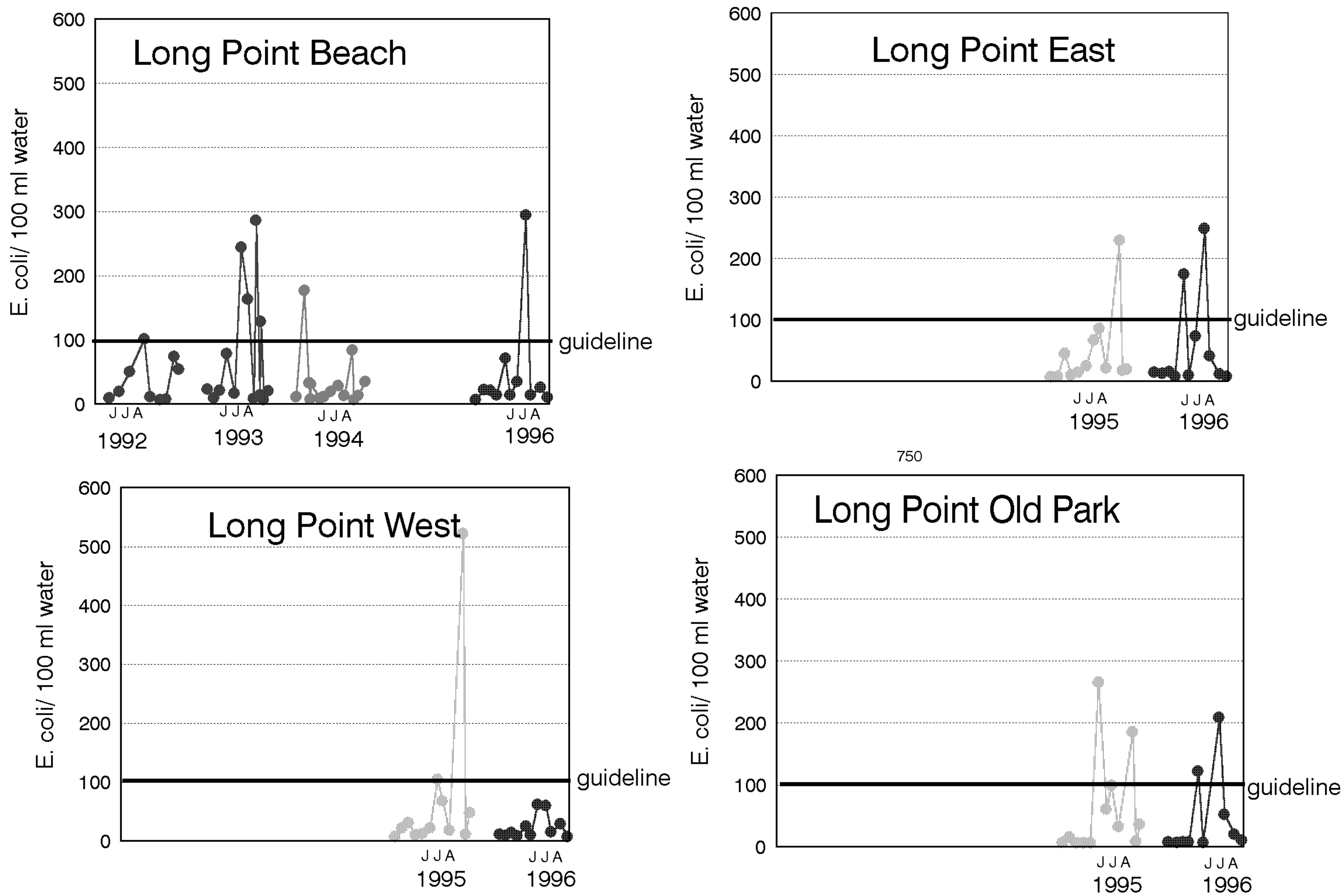

Figure 12-17: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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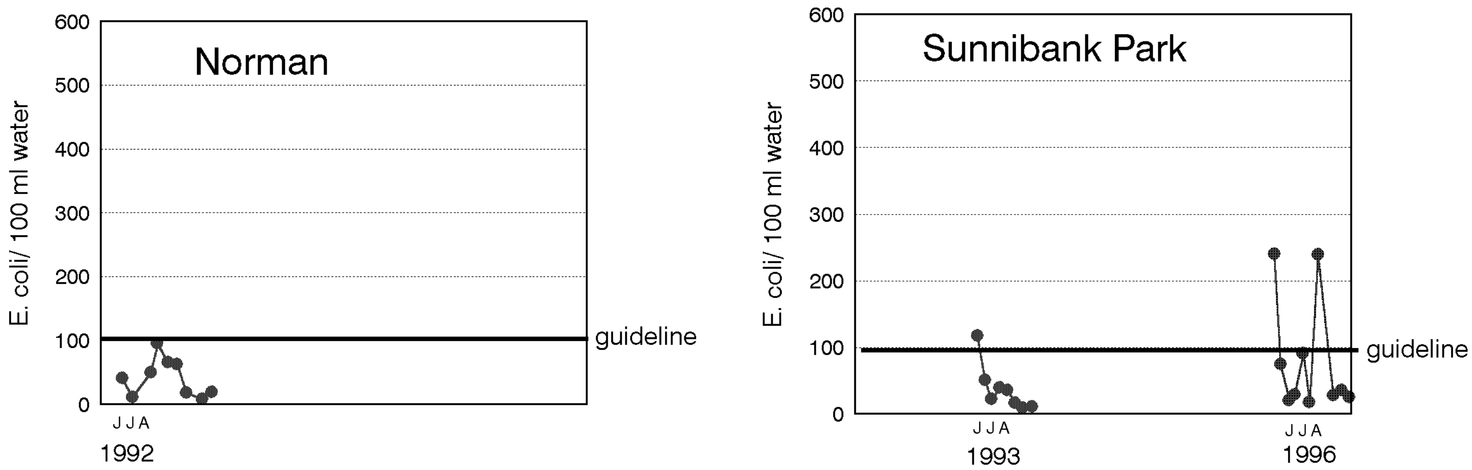

Figure 12-18: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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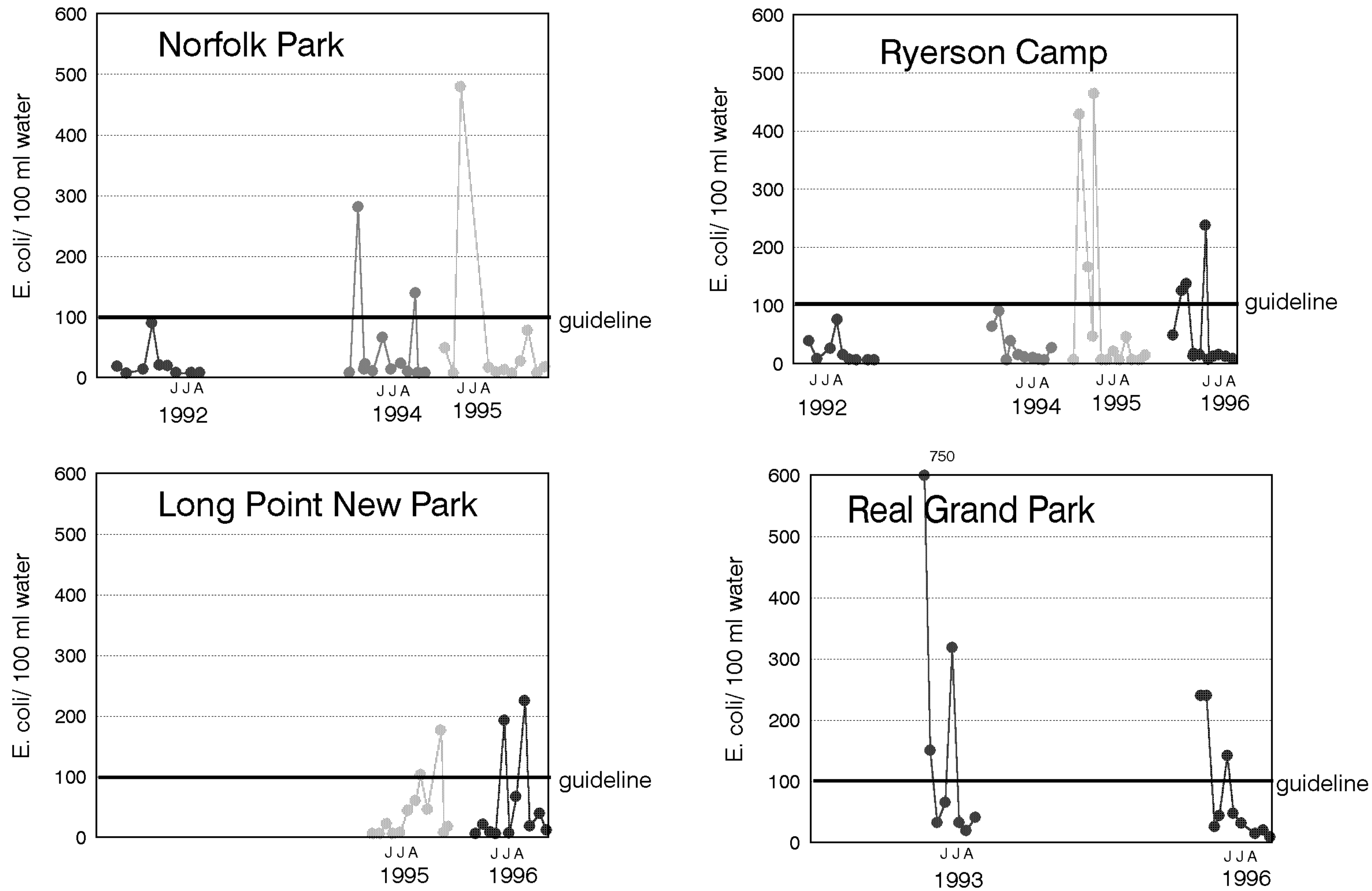

Figure 12-19: Geometric Mean of E. coli Levels in Haldimand-Norfolk beaches, Lake Erie

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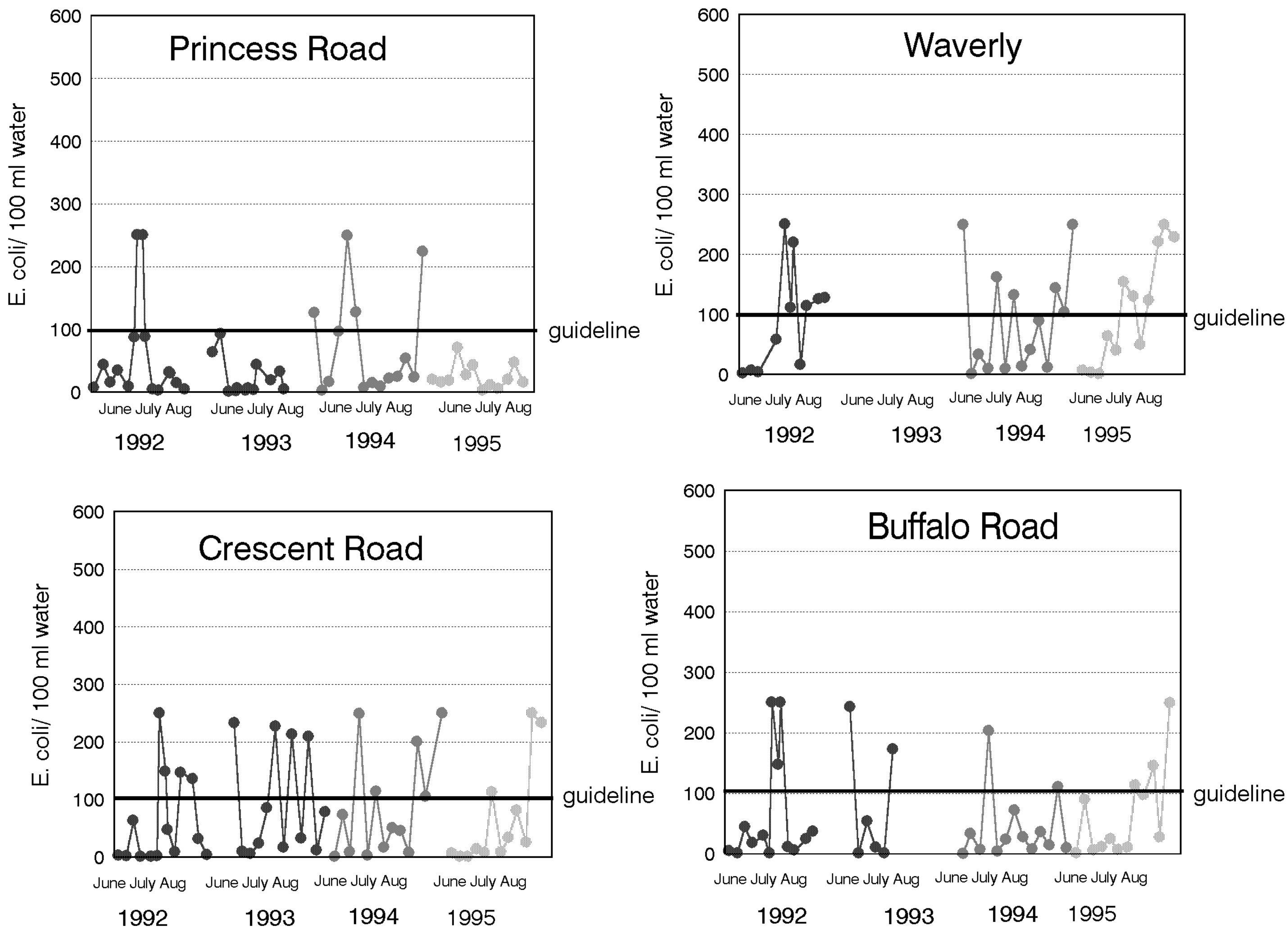

Figure 12-20 : Geometric Mean of E. coli Levels in Niagara beaches, Lake Erie

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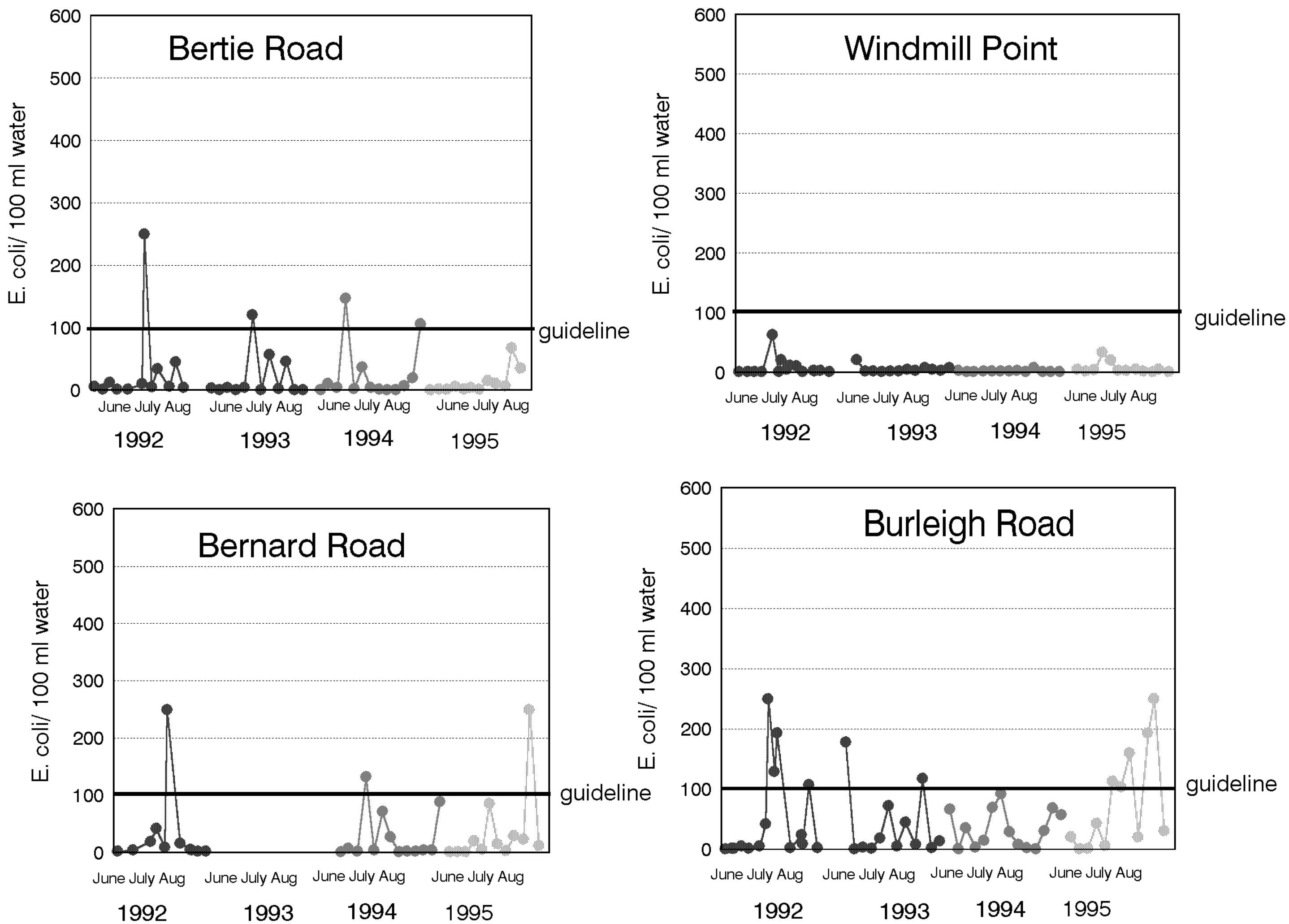

Figure 12-21: Geometric Mean of E. coli Levels in Niagara beaches, Lake Erie

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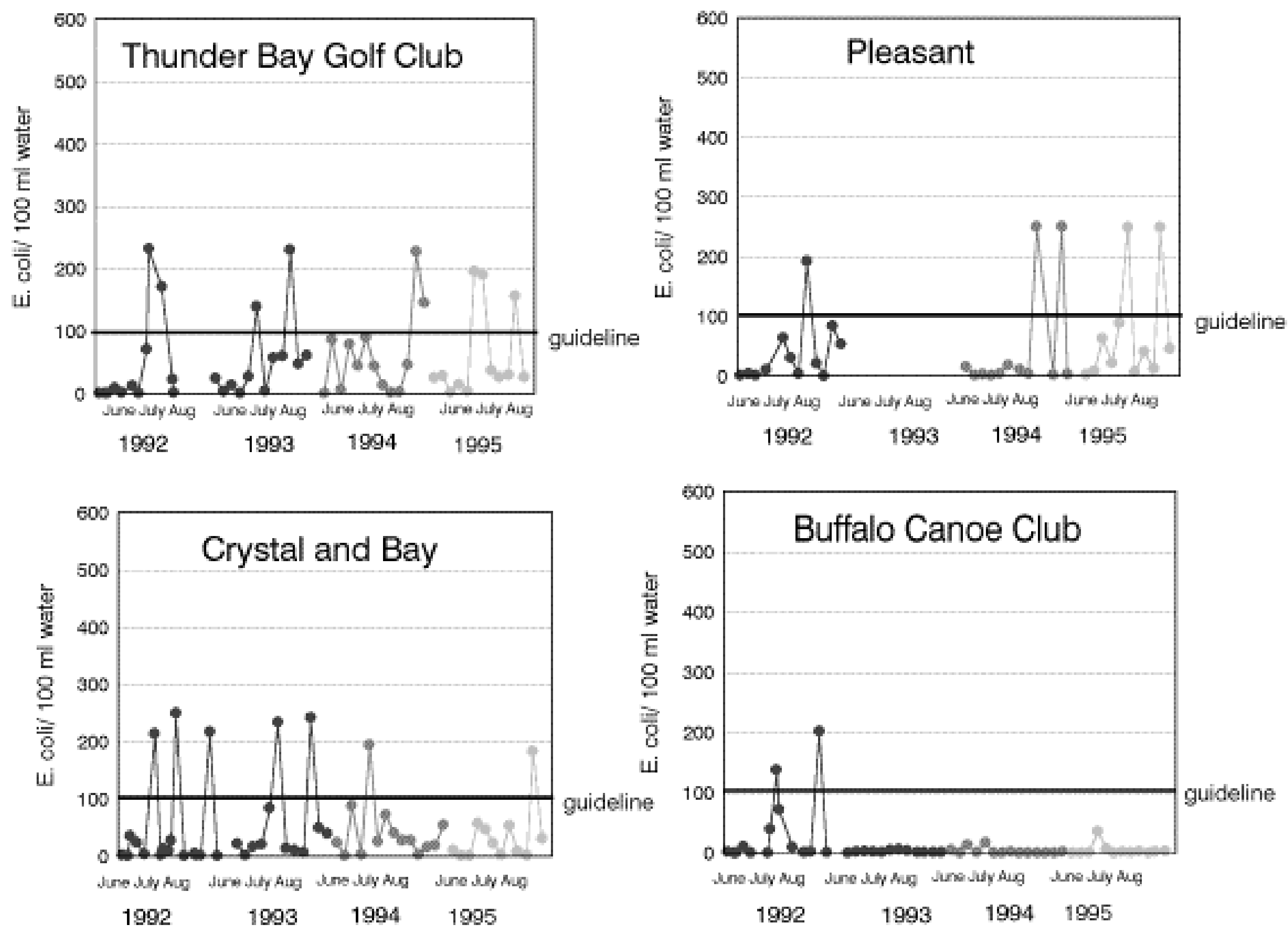

Figure 12-22: Geometric Mean of E. coli Levels in Niagara beaches, Lake Erie

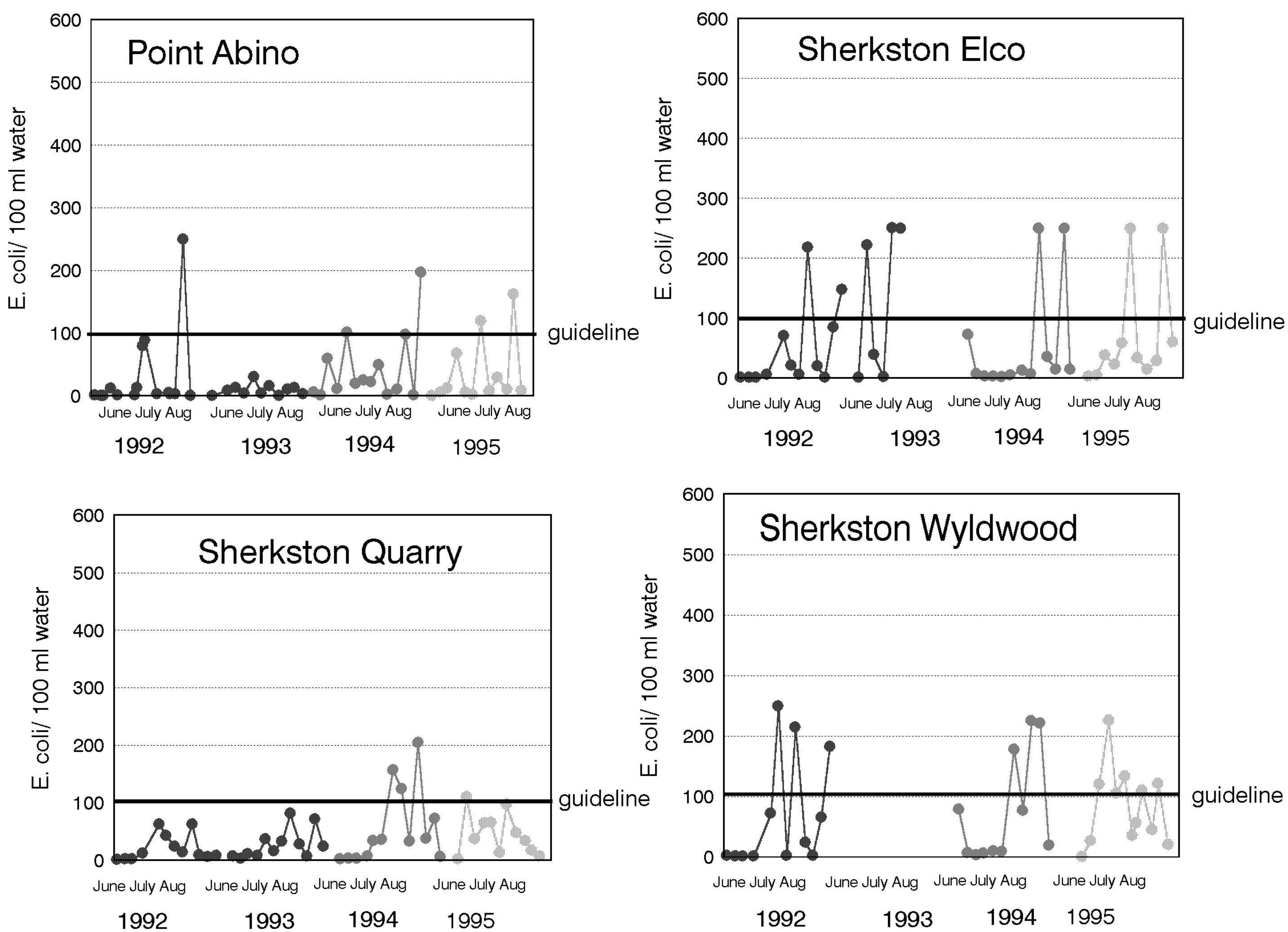

Figure 12-23: Geometric Mean of E. coli Levels in Niagara beaches, Lake Erie

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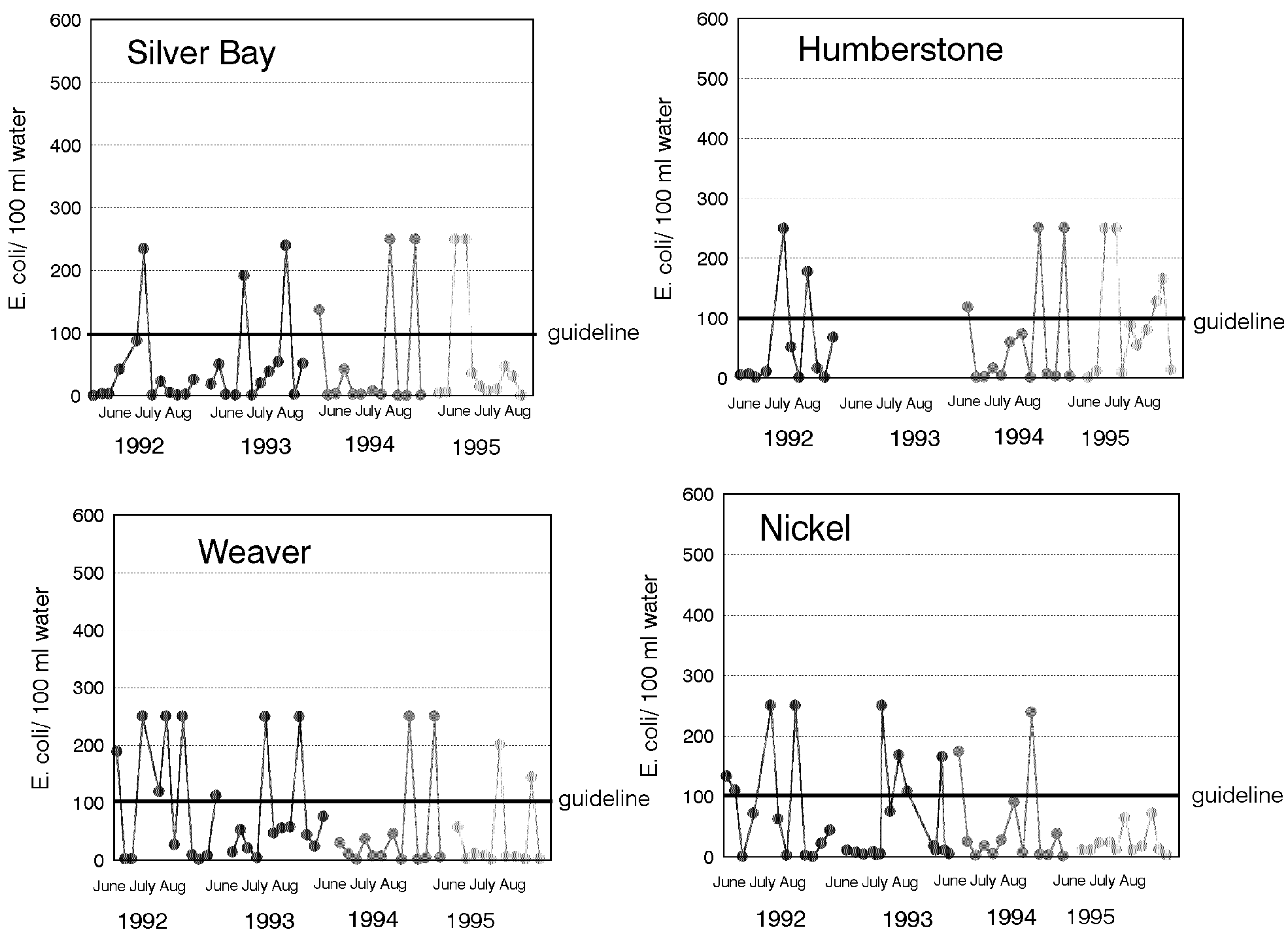

Figure 12-24: Geometric Mean of E. coli Levels in Niagara beaches, Lake Erie

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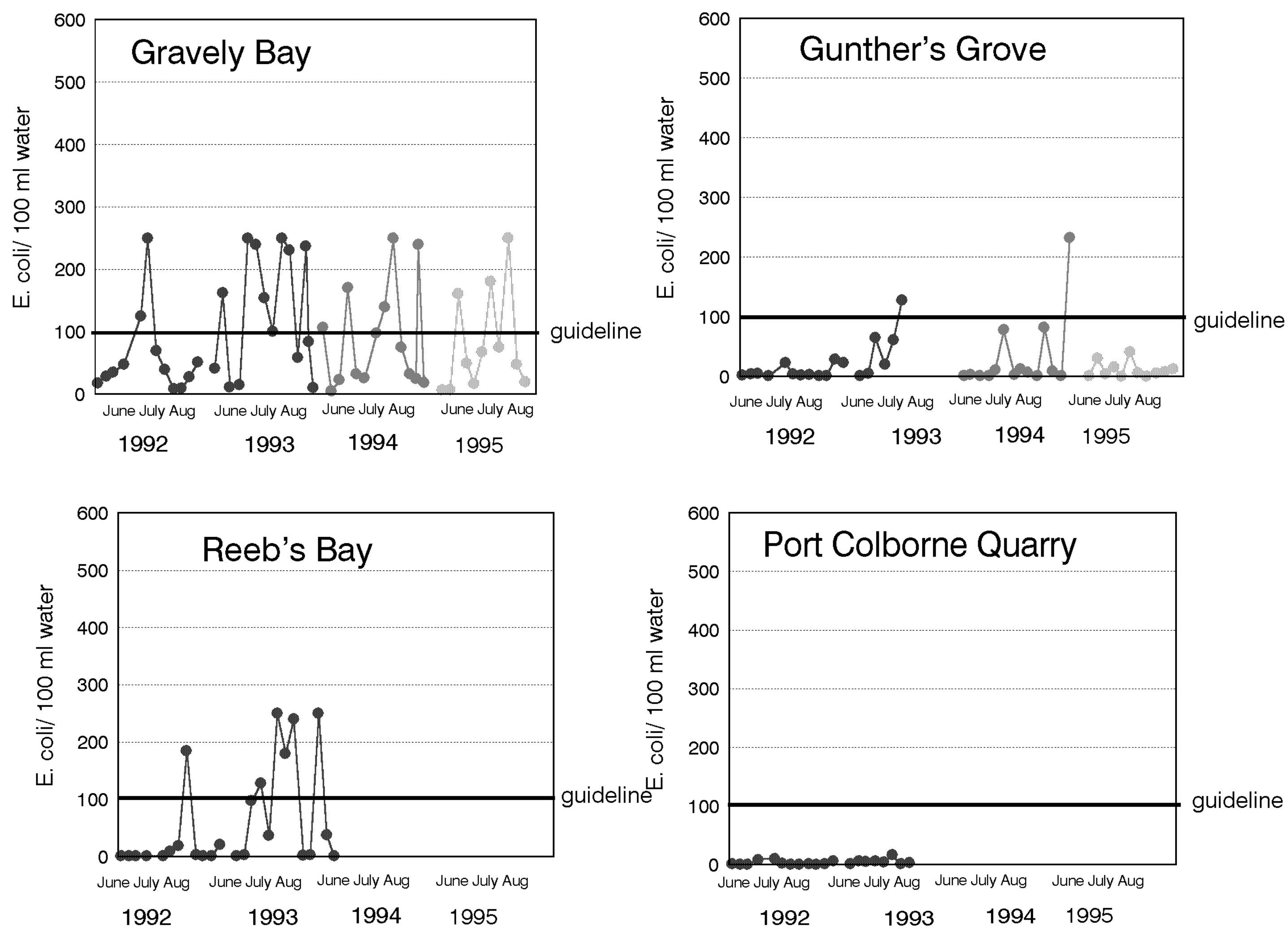

Figure 12-25: Geometric Mean of E. coli Levels in Niagara beaches, Lake Erie

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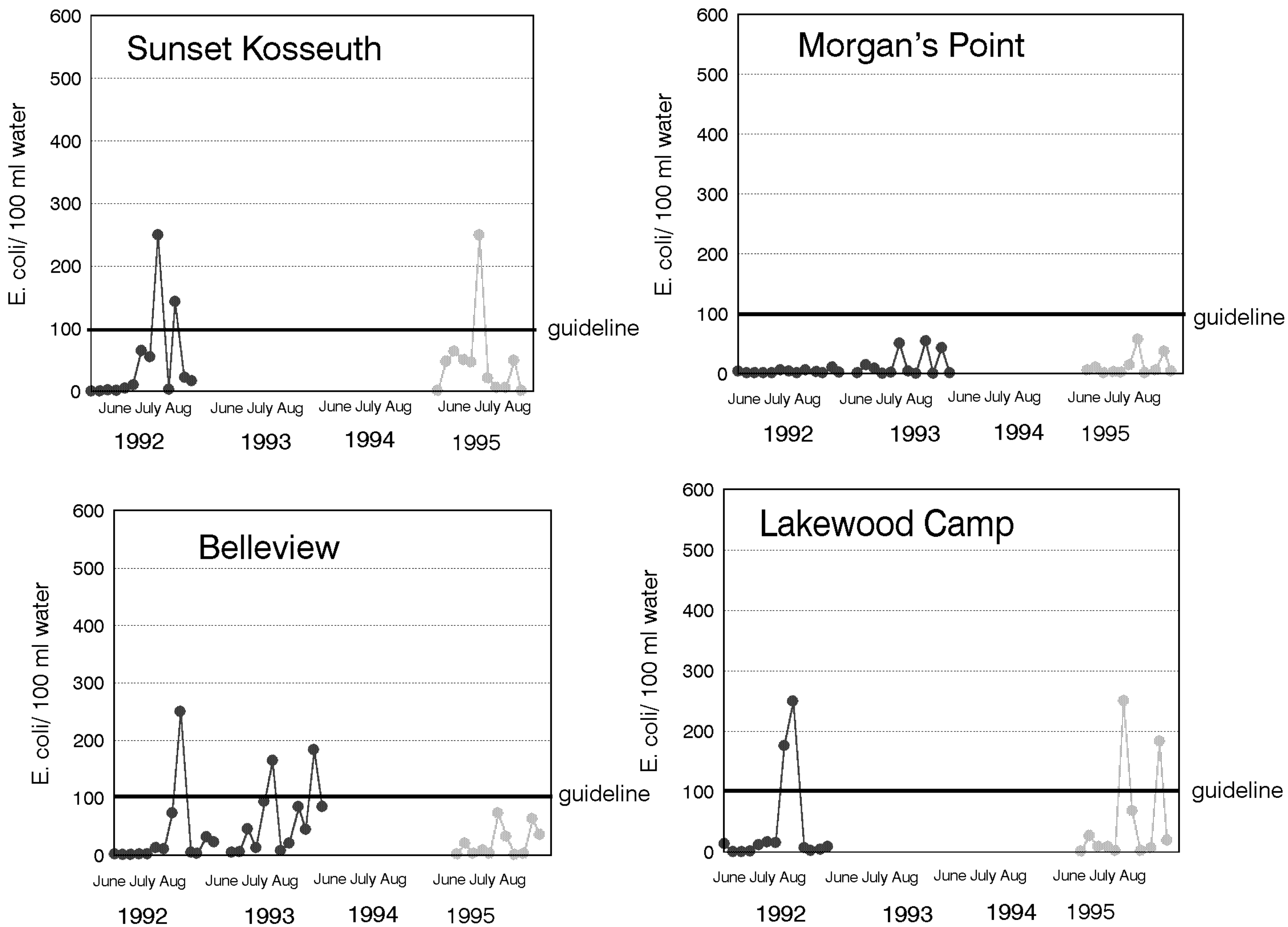

Figure 12-26: Geometric Mean of E. coli Levels in Niagara beaches, Lake Erie

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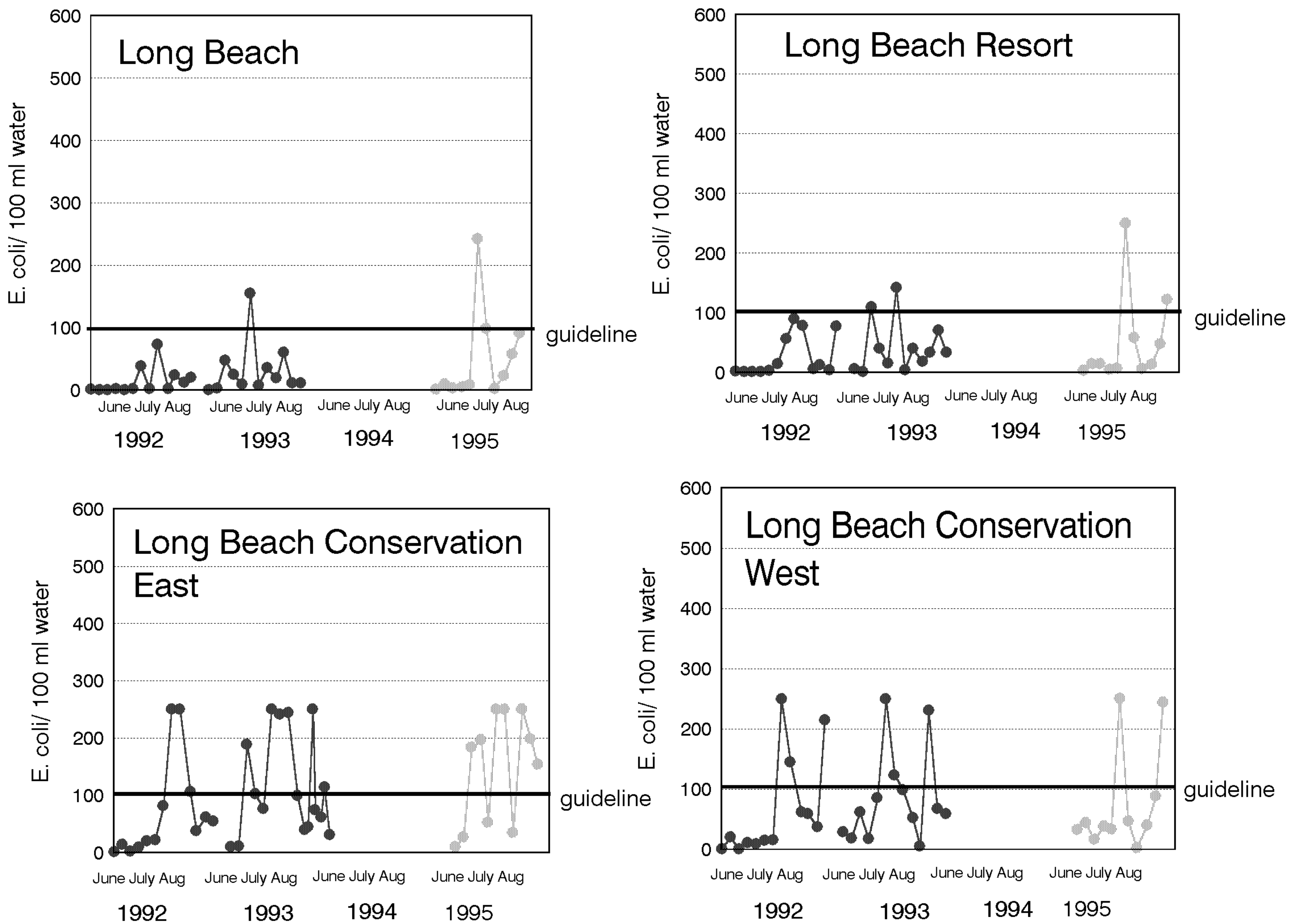

Figure 12-27: Geometric Mean of E. coli Levels in Niagara beaches, Lake Erie

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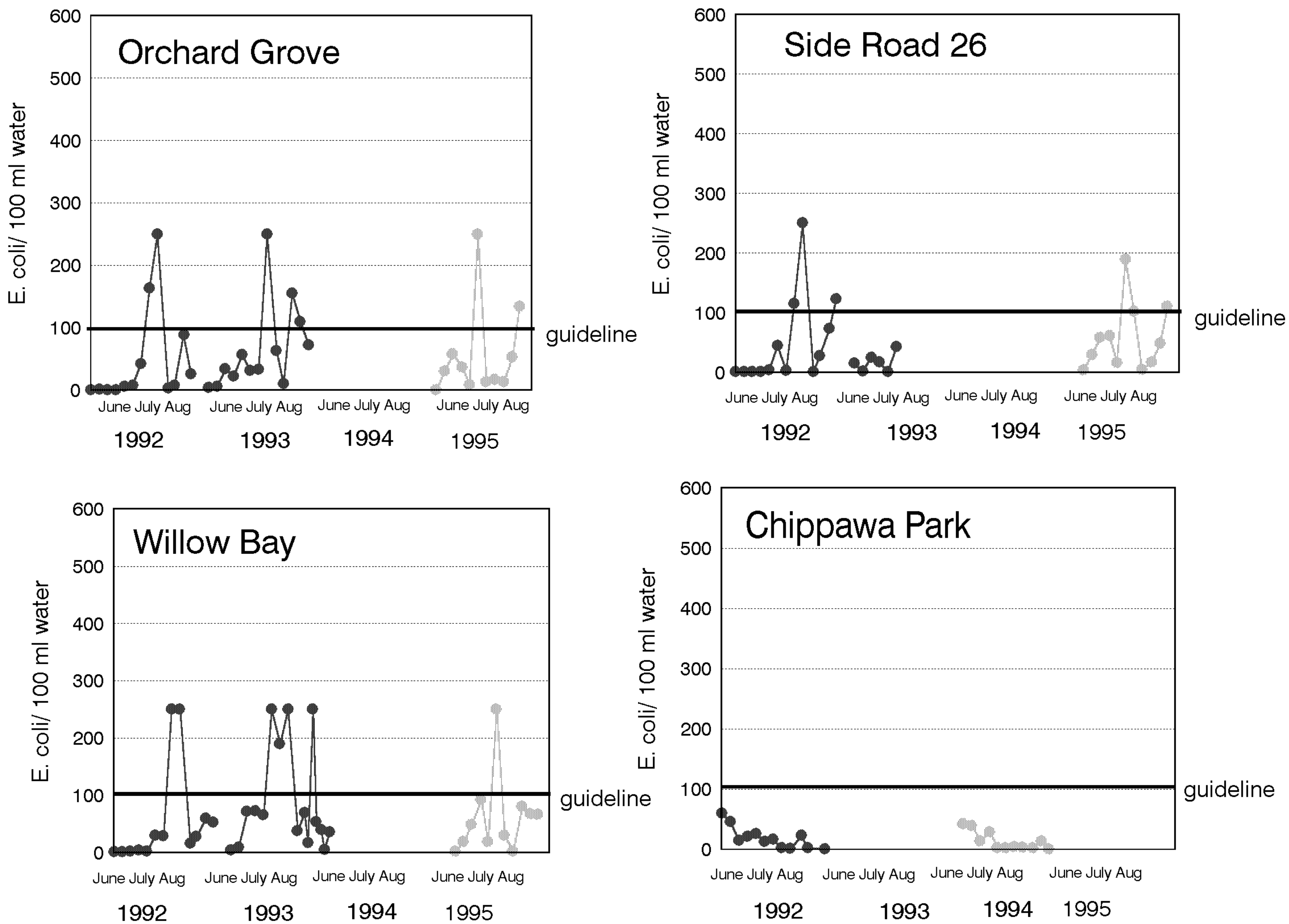

Figure 12-28: Geometric Mean of E. coli Levels in Niagara beaches, Lake Erie

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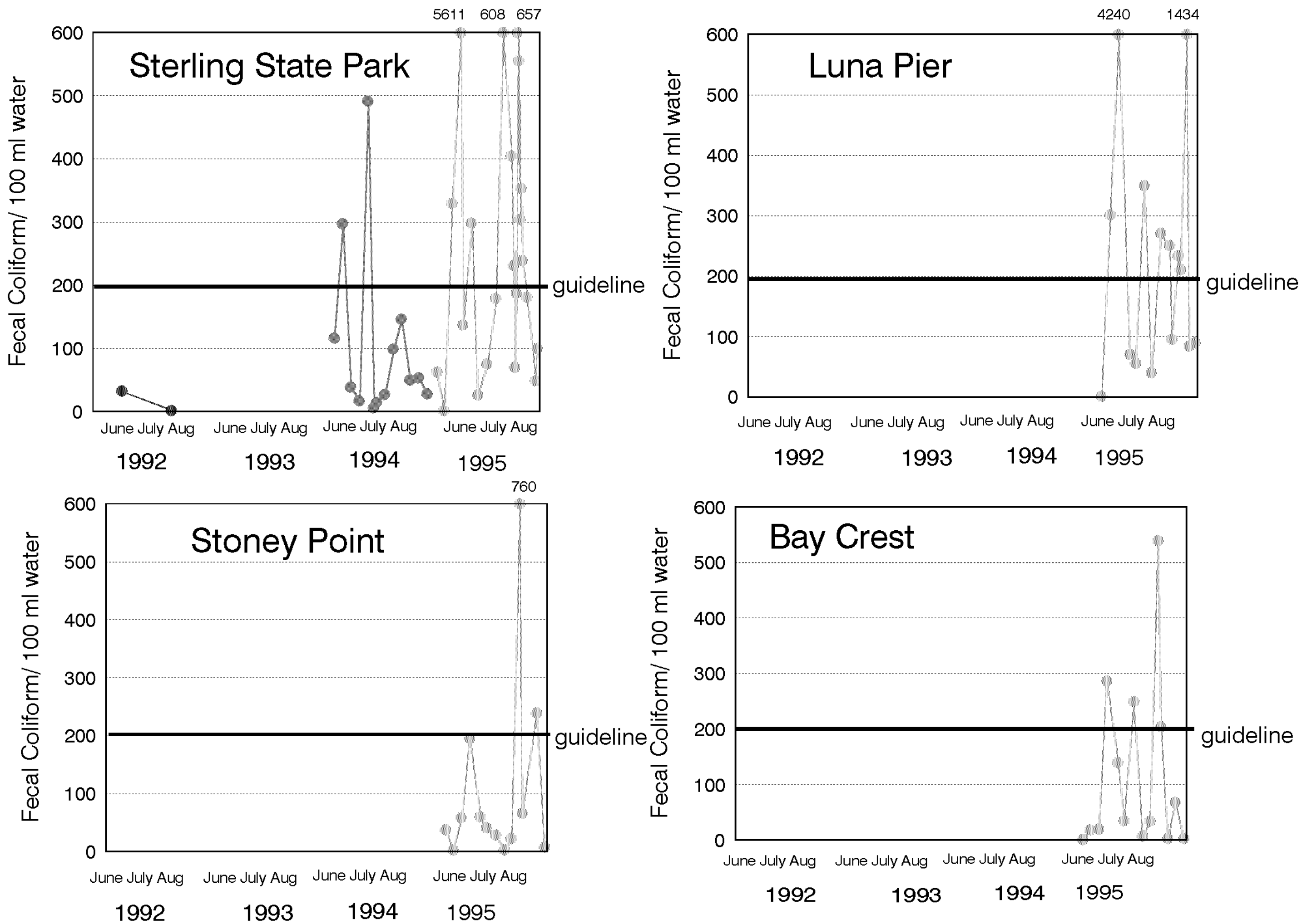

Figure 12-29: Geometric Mean of Fecal Coliform Levels in Monroe County, Michigan beaches, Lake Erie

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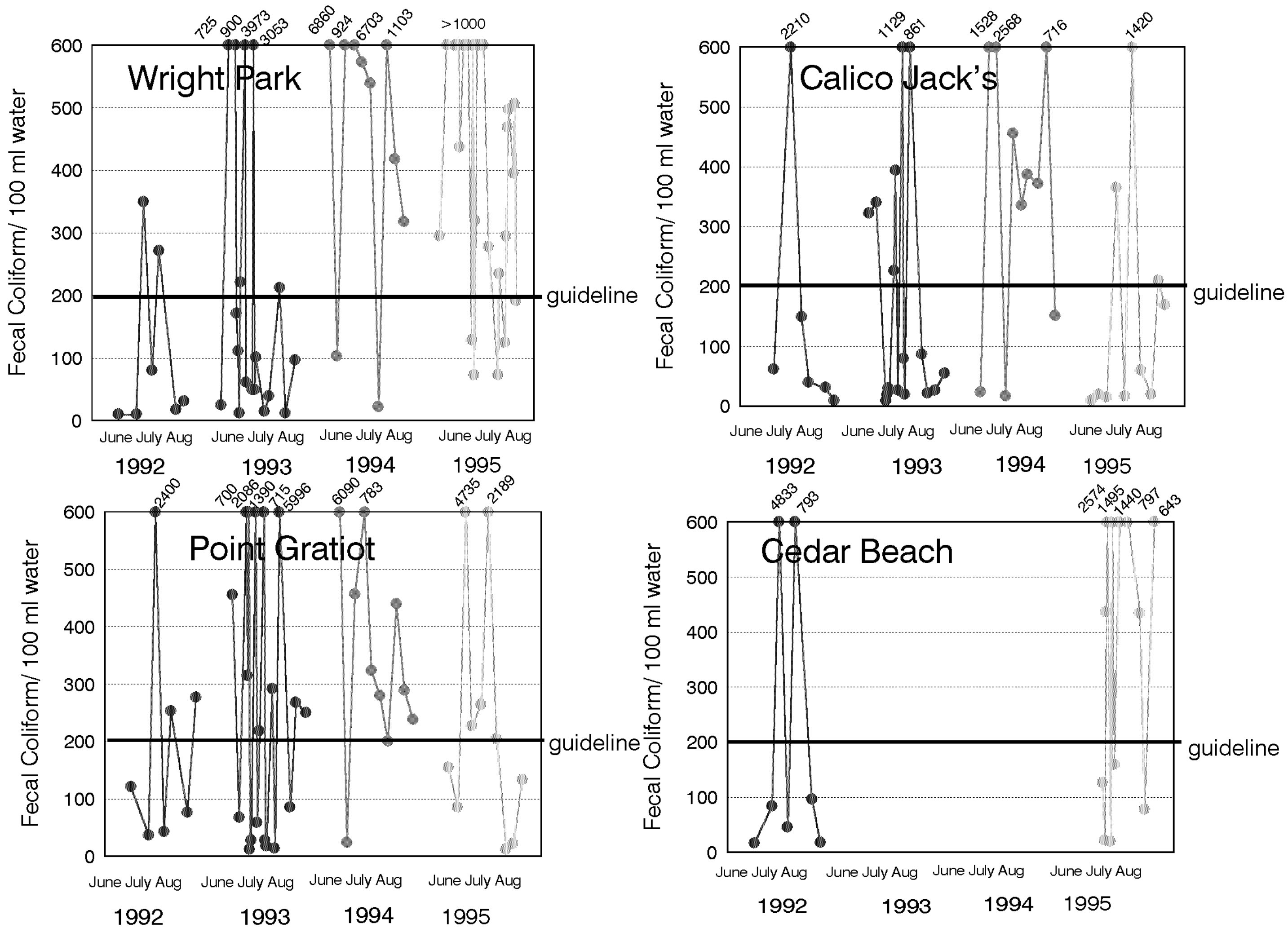

Figure 12-30: Geometric Mean of Fecal Coliform Levels in New York State beaches, Lake Erie

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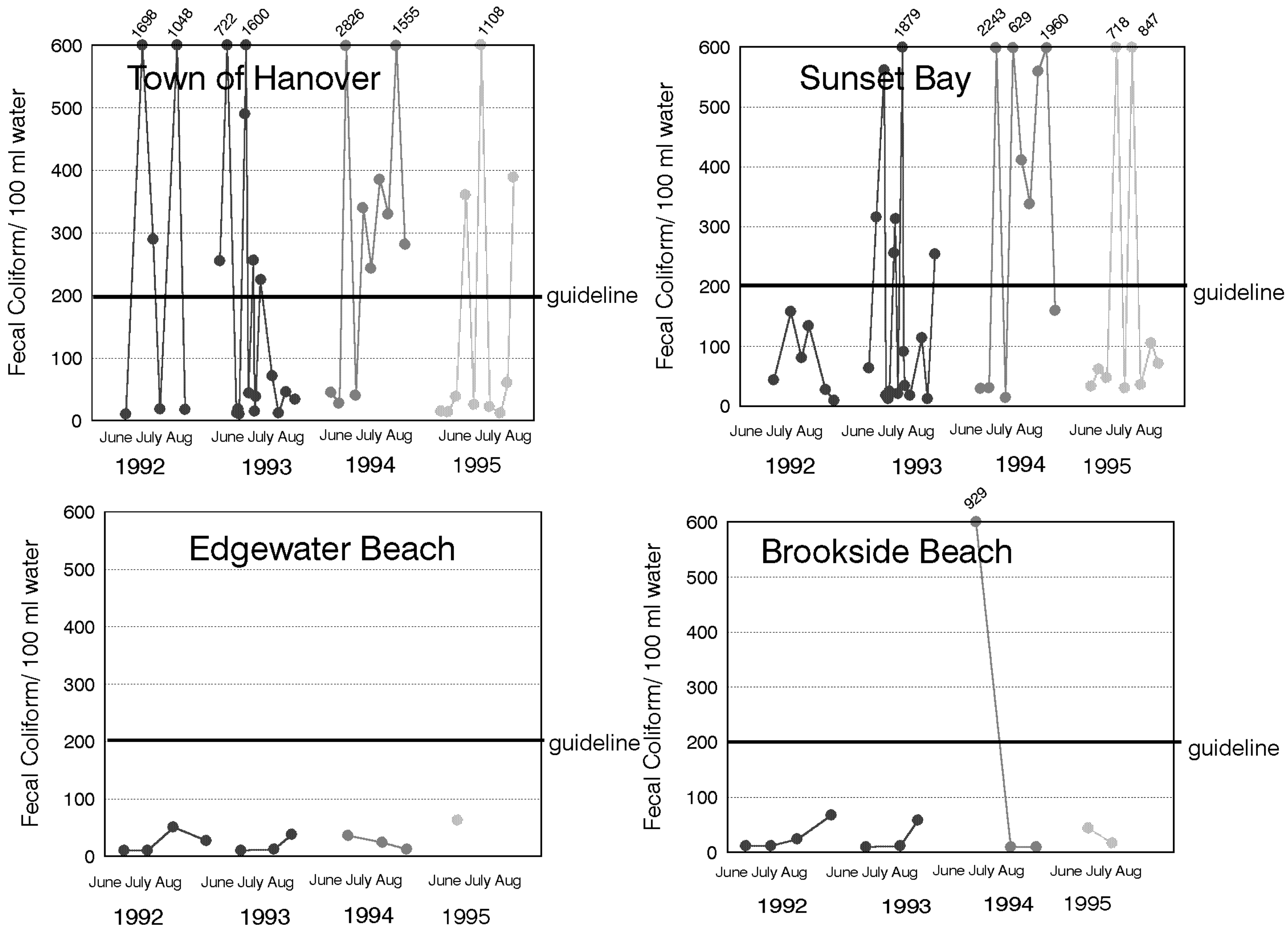

Figure 12-31: Geometric Mean of Fecal Coliform Levels in New York State beaches, Lake Erie

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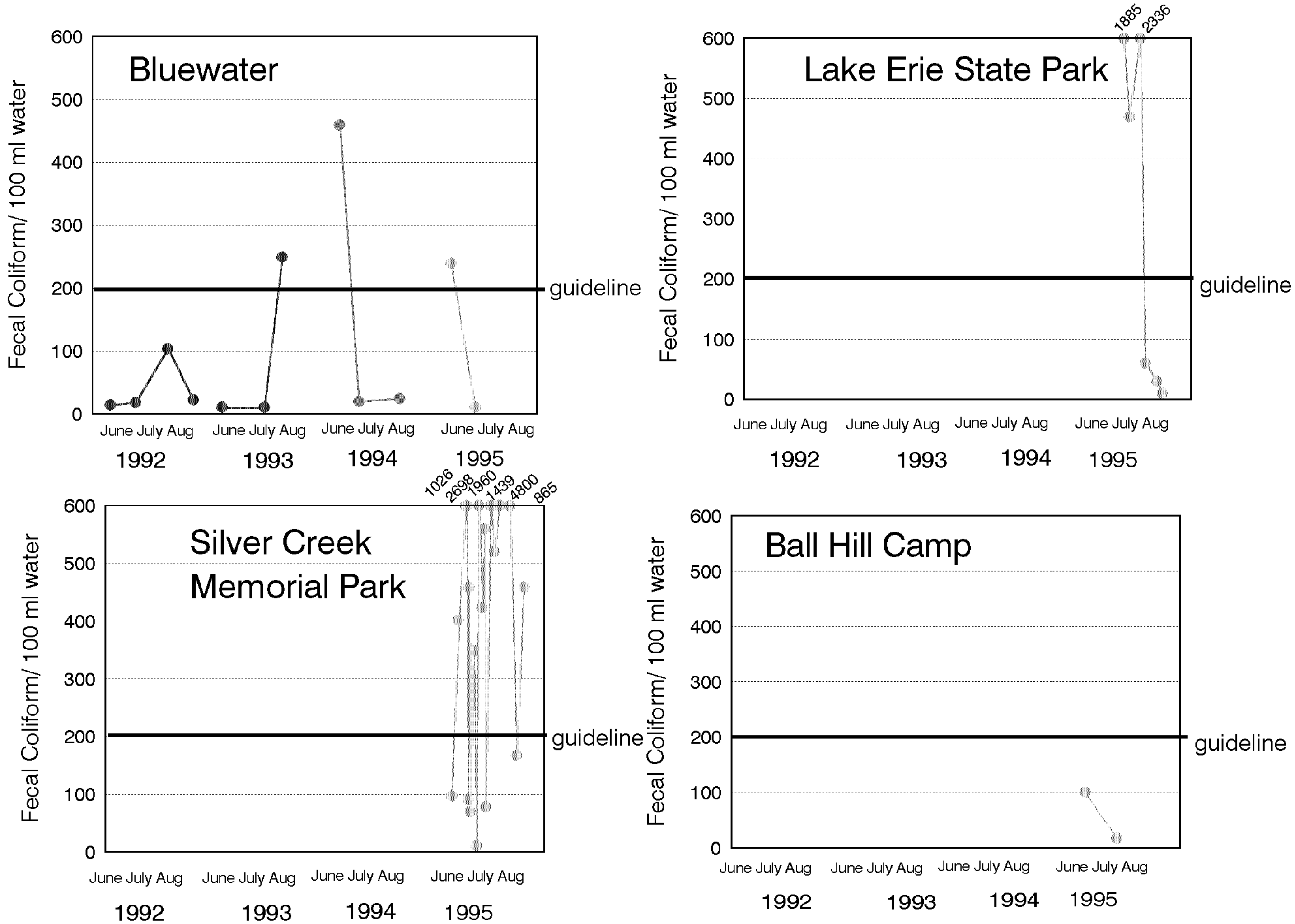

Figure 12-32: Geometric Mean of Fecal Coliform Levels in New York State beaches, Lake Erie

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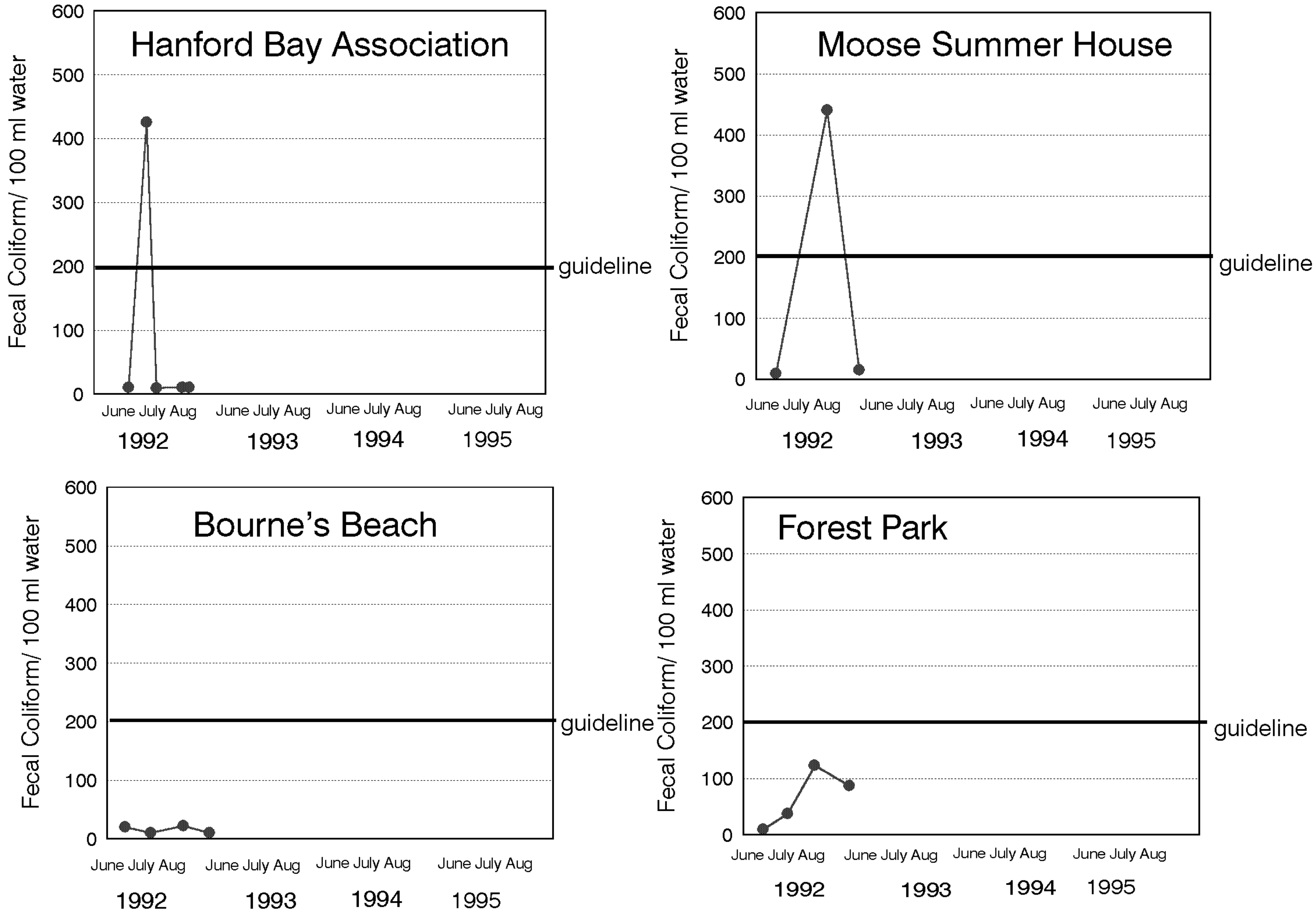

Figure 12-33: Geometric Mean of Fecal Coliform Levels in New York State beaches, Lake Erie

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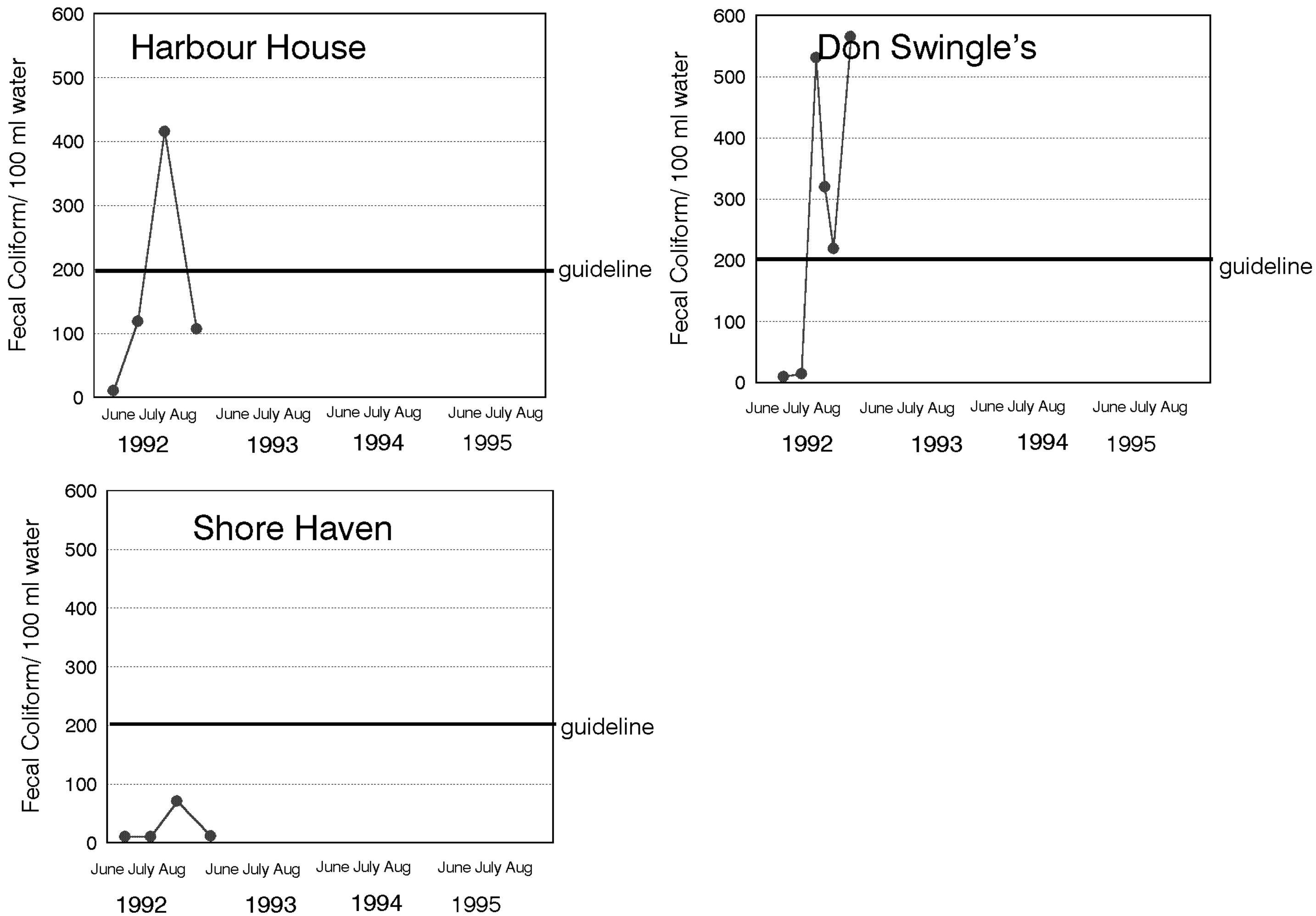

Figure 12-34: Geometric Mean of Fecal Coliform Levels in New York State beaches, Lake Erie

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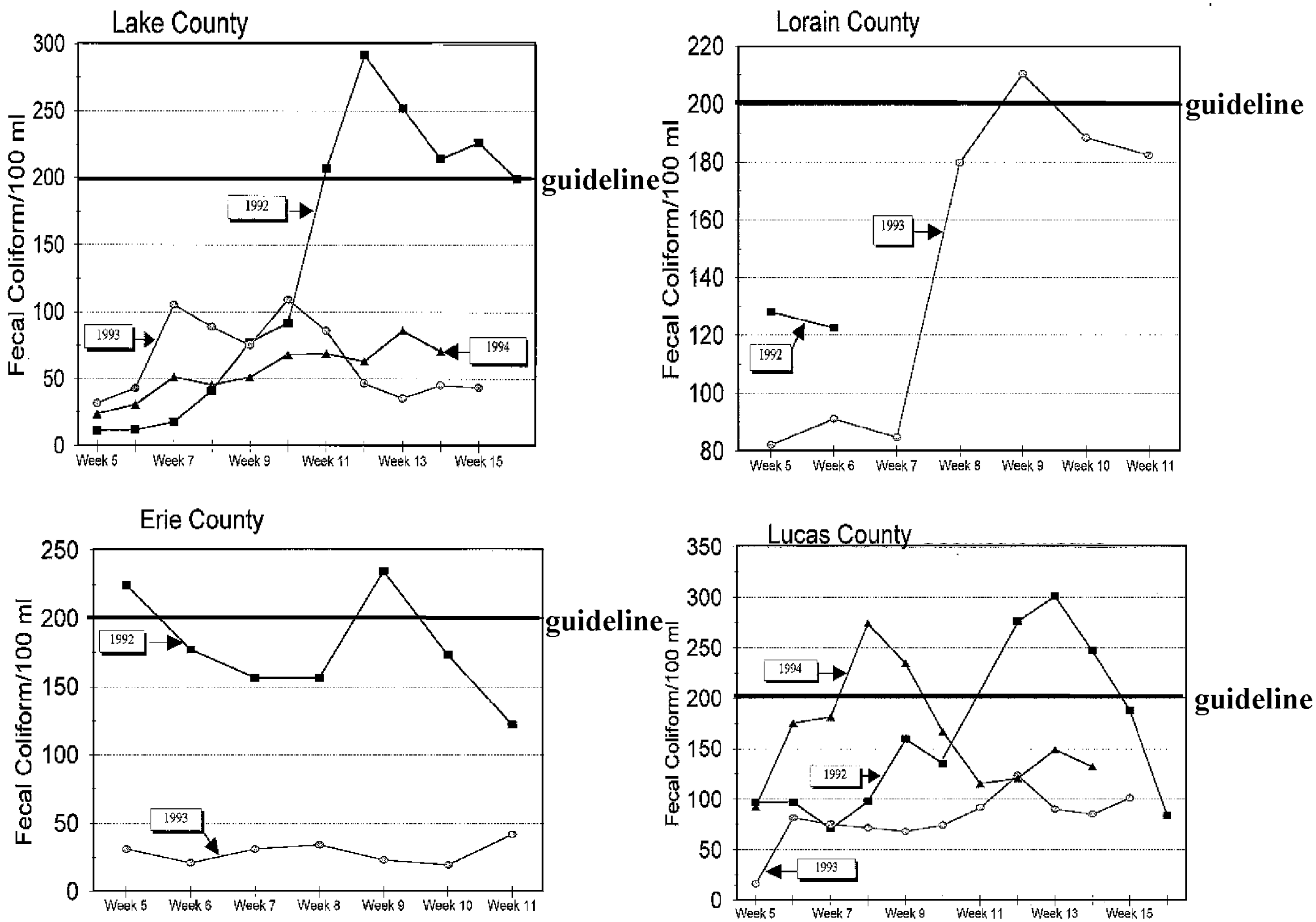

Figure 12-35: Geometric Means of Fecal Coliform in Ohio beaches, Lake Erie.

Week 1 corresponds to the first Tuesday after May 30.

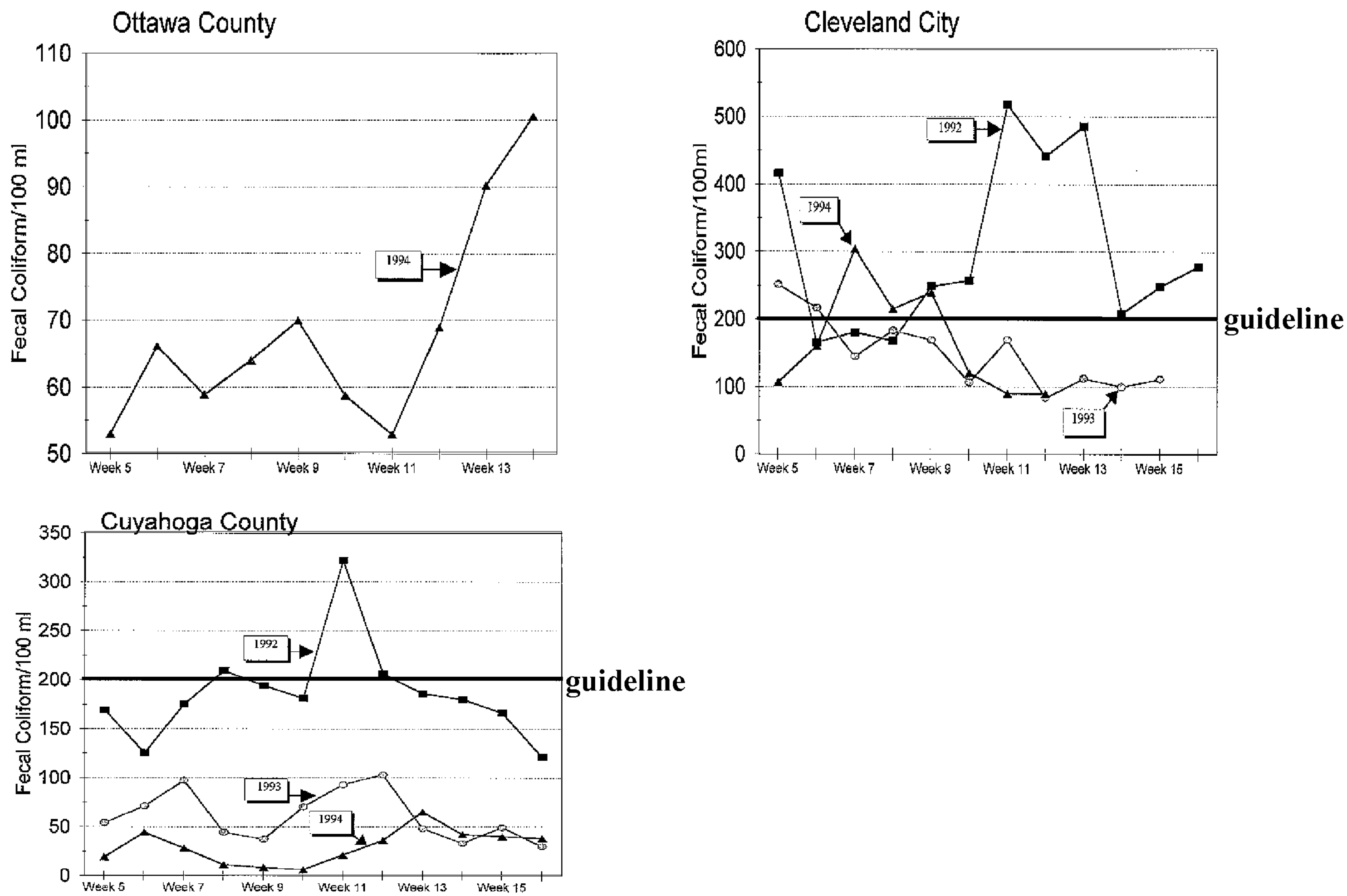

Figure 12-36: Geometric Means of Fecal Coliform in Ohio beaches, Lake Erie.

Week 1 corresponds to the first Tuesday after May 30.

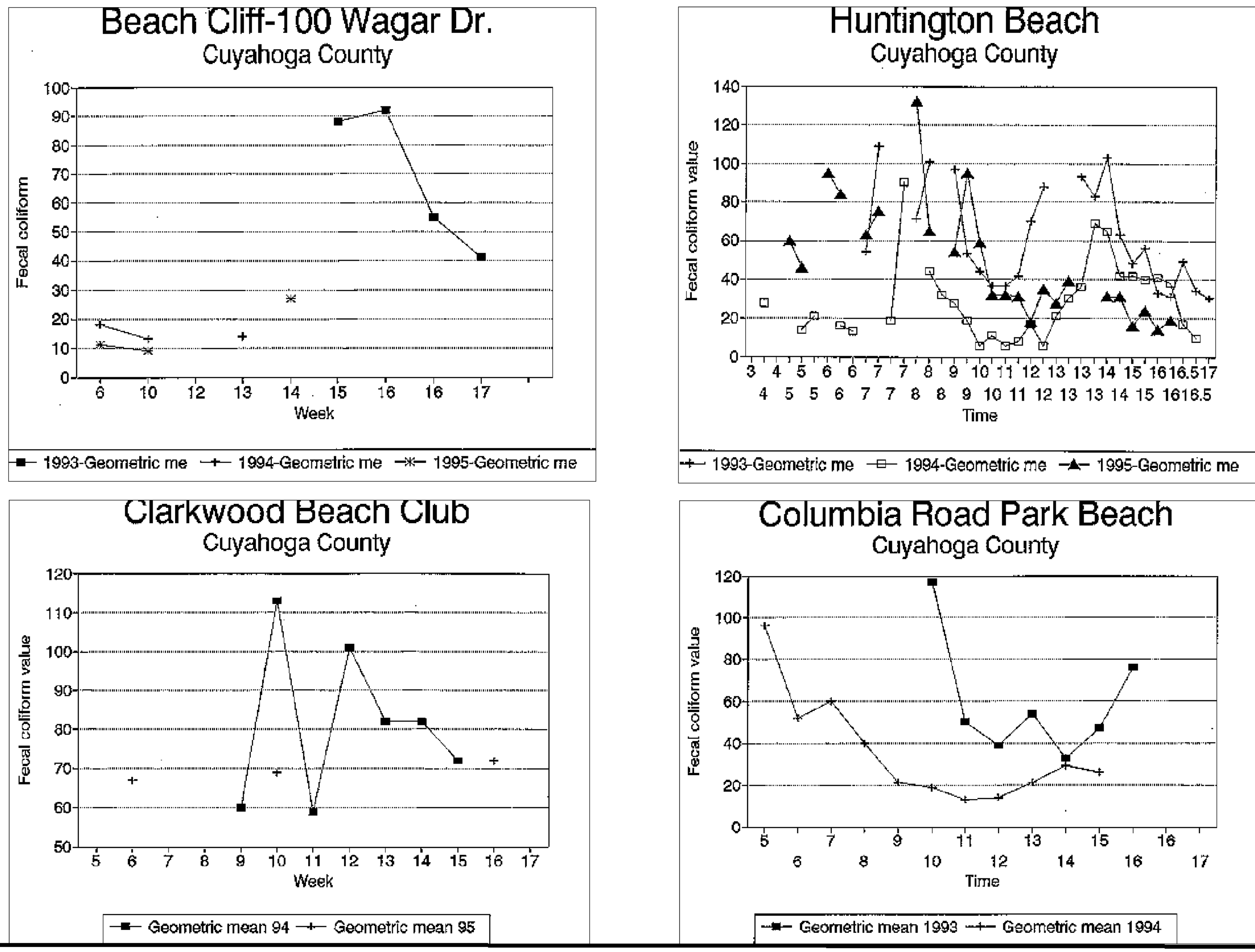

Figure 12-37: Geometric Mean of Fecal Coliform levels in Private Beaches, Cuyahoga County (Ohio), Lake Erie

Week 1 corresponds to the first Tuesday after May 30.

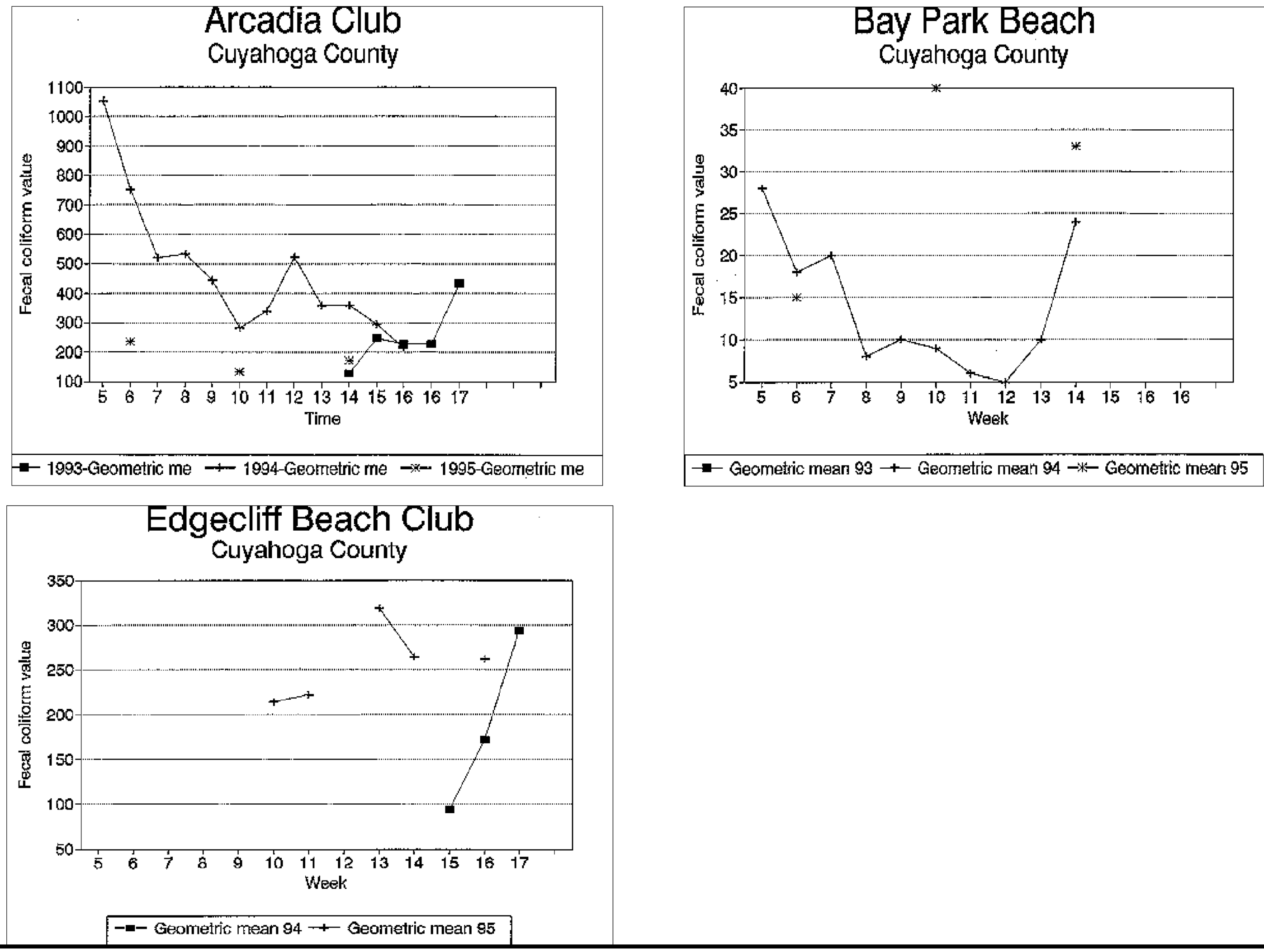

Figure 12-38: Geometric Mean of Fecal Coliform levels in Private Beaches, Cuyahoga County (Ohio), Lake Erie **Week 1 corresponds to the first Tuesday after May 30.**